# The Roles of the Federal Government in Performing Science and Technology: An International Perspective

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Prepared by:

HICKLING ARTHURS LOW
TECHNOLOGY MANAGEMENT, STRATEGY, AND ECONOMICS

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# Executive Summary

This study looks at the roles of the federal governments of five countries in performing science and technology (S&T) as they adapt to a changing environment. The countries are Australia, Finland, the Netherlands, the United Kingdom, and the United States. The study identifies the major trends and forces effecting change, and the responses of federal S&T establishments, by drawing on the literature, national studies, and interviews with S&T officials and academics from each country. The study was prepared on behalf of the Council of Science and Technology Advisors (CSTA).

No country was found to have explicitly defined the roles of their federal government in performing S&T. Where studies were available, they examined the role of the public sector in the National System of Innovation, rather than federal S&T performing organizations specifically. However, those roles can be inferred from the activities of the national organizations. In general, the governments share a sense of responsibility for a common set of areas. What tends to differ, is the degree and manner in which those responsibilities are fulfilled. Differences are strongly influenced by history and the relative strengths of industry and universities across the countries. Differences are also evident across departments within each country.

The following forces were found to be the most significant influences on the roles of federal S&T organizations:

- Fiscal Restraint and Accountability – All governments are being pressured to spend less and spend more wisely with a clear indication of benefits.
- Globalization – The innovation process is becoming more internationalized.
- Technical Change – The rate of change is increasing, time horizons are shortening, and results are expected in the short-term. The private sector is increasingly depending on the public sector science system for long-term R&D.
- Personnel – The scientific workforce is ageing, public sector working conditions are deteriorating, and it is becoming increasingly difficult to retain staff as they are attracted to the private sector or other countries.

The following points discuss the relative strengths and trends of government involvement in S&T:

- *Health* – Health is seen as a very important role for all governments, and that involvement tends to be increasing, especially in the UK and US.

- *Defence* – While defence is still seen to be an important role for governments, that importance is very much stronger in the UK and US, compared to Australia, Finland, and the Netherlands. Spending on defence has decreased substantially in the UK and US.

- *Applied Research* – Government involvement in applied research has been steady or decreasing in all of the countries, except for Finland where there has been a concerted effort to increase applied research. The declines stem mostly from reductions in defence spending. There is a trend towards increased industrial relevance.

- *Basic Research* – Government involvement in basic research is weak in Australia and Finland, and strong in the Netherlands, the UK, and the US. The US in particular sees basic research as vital to their dominant position in the world.

- *Industrial Support* – Providing support for industry is seen as very important in all of the countries surveyed.

- *International Cooperation* – All of the countries see international cooperation as very important, and Australia and Finland are actively working to increase that cooperation. However, the increase in cooperation is set in the context of increasing international competition. The US, in particular, is struggling with the recognition of the importance of international cooperation on the one hand, and rising protectionism and concerns about foreign access to research results on the other hand.

- *Standards and Regulations* – All of the governments are actively involved in standards and regulations.

While the preceding list contains common areas for government *involvement*, no generalizations can be made about the role of governments in *performing* S&T. There is a wide spectrum of possible ways to achieve national goals. Financial models can vary from in-house performance of S&T, through cost recovery and contracting-out, to privatization. S&T can be performed with varying degrees of partnerships and linkages among government, industry, universities, and international performers. And, governments can vary their involvement in the setting of national S&T priorities. All governments have tried many combinations of these approaches, often at the same time across departments. There is no evidence that there is any 'right' approach.

What can be said is that there is a general consensus that:

- There is a role for public involvement in S&T;

- At a minimum, government needs to have the internal capability to understand S&T issues, advise on the appropriate public involvement, and ensure the public good; and

- The development and maintenance of that internal capability requires some activity in the performance of S&T.

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# 1. Introduction

## *1.1 Summary*

Over the past decade, public sector science and technology has experienced vast restructuring and reorientation in all five countries under review: Australia, Finland, the Netherlands, the United Kingdom and the United States. A need for greater financial accountability in times of high public debt burdens, rapid technical change, and a renewal of outdated missions following the end of the Cold War, are but some of the major factors affecting not just national laboratories but the entire innovation system of nations. Although the structure of the economy and historical precedents largely determine the nature of each country's response, there is an undeniable trend towards 'new public management' of government S&T establishments to accommodate the on-going changes. Contract-based competitive supply, private sector management styles, and partial commercialization of research activities have been introduced in national laboratories of all countries to various degrees, with Australia and the UK taking the lead. The resulting strain incurred by such measures has come to a head in the Netherlands where talk has begun of dividing institutions along market-oriented versus research-oriented lines.

The rethinking of missions and priorities has been the subject of several reviews. All countries, in response to economic pressures and recognition of the limits of government in the economy, are tailoring S&T priorities to national interests. Foresight programs and critical technology lists are now widely used as policy tools, with however, varying degrees of influence in the UK, the US and the Netherlands.

Although government R&D funding has declined in most countries, with the notable exception of Finland, support for basic research within the science system has remained relatively constant. Defence related R&D, despite having received the most severe cutbacks, continues to receive the greatest portion of government R&D spending in both the US and UK.

With the increasing awareness of the role of innovation to economic health, government S&T for the most part remains committed to the concept of the national innovation systems. Programmes institutionalizing linkages between government S&T establishments, industry and universities continue to be popular as a means of maximizing benefits from the innovation system. In countries such as Finland, the national innovation system approach has been used as the basis for national policy planning since 1990. That this support for the innovation system will continue is likely given recent evidence that firms are increasingly dependent on public science and that new innovations are increasingly dependent on advances in basic science.

The trend to growing internationalization, in both science and the innovation process, continues to be encouraged through initiatives aimed at improving international co-operation in science and technology. The UK LINK program, for example, allows foreign participants restricted participation in what was once a national program to support pre-competitive R&D. The extent to which internationalization affects federal S&T establishments will likely depend on the degree of involvement in such initiatives.

## *1.2 Background*

This study, prepared on behalf of the Council of Science and Technology Advisors (CSTA), examines the roles and operations of government science and technology establishments of five countries as they adapt to a changing environment. Drawing on the literature, national studies and reports, as well as interviews with S&T officials and academics from each country, the study identifies the major trends and forces effecting change on federal S&T establishments and their responses to these changes. The factors identified have been interpreted in the context of the larger innovation system since changes in the government's role as an S&T performer cannot be interpreted in isolation from the changes affecting other S&T actors.

The countries reviewed are Australia, Finland, the Netherlands, the United Kingdom and the United States. Although each country shares attributes with the Canada S&T system, the national character of both the R&D system and policies is very much contingent on historical circumstances and the nature of the economy.

This report begins with an overview the major trends affecting government S&T establishments and the responses to these trends as determined from a review of government reports, relevant literature and interviews with science and technology officials. In the sections that follow, the specifics of each country are given including details of funding trends of government S&T, priority setting mechanisms and summaries of S&T reviews.

# 2. International Responses of Government Performed S&T

With the science system, and in particular the federal science system, being a subset of the larger national innovation system, global forces of change such as technical change and globalization, invariably affect both systems. What is more, the majority of the forces responsible for the changes are very much interdependent and have, in part, co-evolved with the responses by government. Consequently there are no singular responses to any particular trend affecting government-performed science and technology. This section begins with an overview of the forces affecting government S&T as discussed in the OECD literature, learned journals and the popular press. Categorized under four broad headings, fiscal restraint and accountability, globalization, technical change and personnel, these forces provide a very general context of *why* governments are reorienting their S&T establishments. This is followed by a synthesis of official reports and interviews to show *how* governments are responding to the changes.

**Responding to the changes**

Of the countries under review, none had completed an in-depth report on the role of government in performing S&T. The subject, however, has been a topic in major and minor S&T reviews, studies, and policy statements of the five countries to varying degrees. The studies most relevant to this review are the 1998 Netherlands report, *The Use Of The Large Technological Institutes*, which looks at the significance of links, competition, collaboration, and administrative responsibilities, and, the 1997 Australian review, *Priority Matters*, which looks at priority setting, gaps and overlaps in the science system as a whole. In the upcoming year, the UK will be publishing the results of two studies looking at the privatization of government S&T establishments. Table 2-1 provides a summary of some of the reports.

***Table 2-1: Summary of recent government reports***

| Country | Reports | Year | Relevancy to government S&T |
|---|---|---|---|
| **Australia** | Priority Matters (Chief Scientist) | 1997 | Investigates gaps and overlaps in S&T, ways of identifying national priorities. |
| | Research and Development (Industry Commission) | 1995 | Comprehensive review of all government S&T activities. |
| | Matching Science and Technology to Future needs: 2010 | 1994 | Use of Foresight in Australia, global integration, sustaining the environment, information technology, changing international relationships. |
| **Finland** | Finland: A Knowledge-Based Society | 1996 | Development of the research system, international S&T co-operation, utilisation of S&T knowledge. |
| **Netherlands** | The Use of Large Technological Institutes (AWT) | 1998 | Significance of links, problems with collaborations, competition. |
| | Policy report regarding Foresight Studies (AWT) | 1996-1998 | |
| | Advisory report on Institutes for Fundamental Research (AWT) | 1995 | |
| | A Vital Knowledge System: The Future of Dutch Research, (OCV) | 1996 | Identifies knowledge themes for focusing R&D. |
| | Benchmarking the Netherlands (Ministry of Economic Affairs) | 1995 | Includes benchmarking of S&T. |
| **United Kingdom** | Our Competitive Future: Building the Knowledge Driven Economy | 1998 | Initiatives to encourage competitiveness and innovation through improved S&T linkages and knowledge transfer. |
| | Forward Look (OST) | 1996 | Sets out measures in response to 1993 White Paper. |
| | Realising Our Potential | 1993 | Introduced foresight process, reorganized research councils, customer/contract principle strengthened. |
| | The Next Step Initiative | 1988 | Introduced new public management approach to government S&T establishments. |
| **United States** | Unlocking Our Future: Toward a New National Science Policy (House Committee on Science) | 1998 | Recommendations on ensuring continued dominance in science. |
| | Science in the National Interest (White House) | 1993 | Stipulates S&T goals for the Clinton administration. |

## 2.1 Trends in government performed science and technology

### 2.1.1 Fiscal restraint and accountability

Perhaps one of the more immediate and obvious changes in the innovation system affecting government performed S&T has been the budget cuts to S&T programs in many of the major R&D performing nations. The end of the cold war, inflated budget deficits from the world-wide recession of the late 1980s and early 1990s, and an increasing awareness of the limitations of the government's role in the economy, are the major instigators of this trend. Calls for financial accountability and returns on investments can be heard from all major R&D performers as changes are made to the funding of R&D. Apart from Finland, which is aiming to increase its government R&D expenditure from 2.2 percent of GDP in 1994 to 2.9% by 2000, the countries compared showed either a decline (Netherlands, United States) or relative stability (United Kingdom, Australia) over the 1991-1995 period (OECD 1998).

**Funding of government performed S&T**

Although overall government funding in R&D has declined in most countries since the 1980's, there is no clear trend in government funding of public sector research (Figures 2-1 and 2-2). When examined in terms of government research performed by character of work (i.e. basic, applied) however, support for basic research remains steady while development based research shows a decline (see country chapters). This decline can, for the most part, be attributed to cuts in defence R&D, which is primarily development based. As for the continued support for basic research, an improved understanding of the role of research in the economy has helped in this matter (Box 2-1).

Since the United States is the only country where the private sector performs most of the government funded R&D, it has the lowest government expenditure in public sector research. Finland was the only country to increase government funding for R&D, most of which was targeted for applied research and not for basic funding of the research institutes or universities.

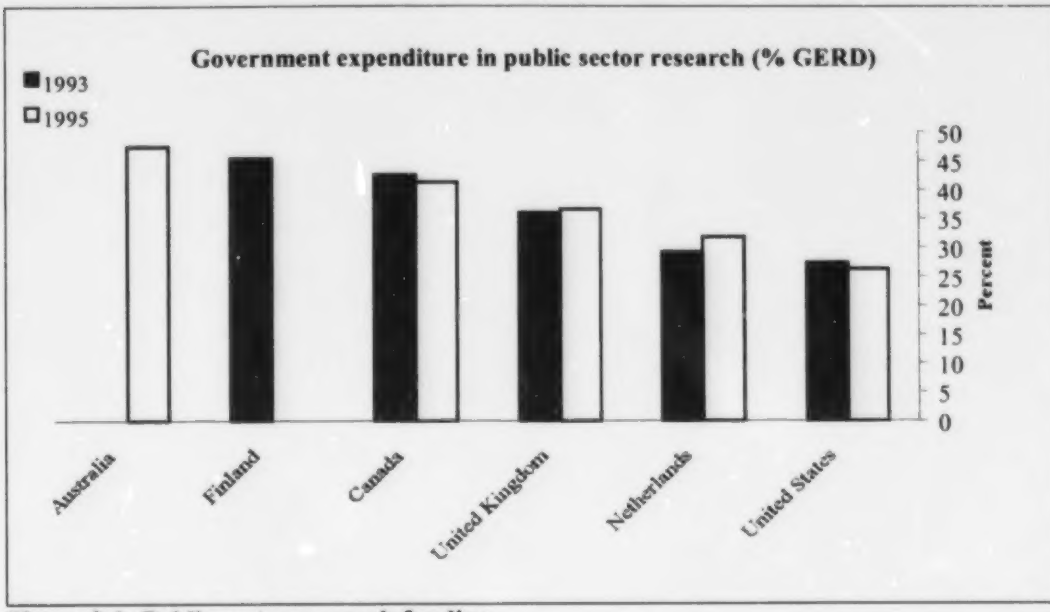


**Figure 2-1: Public sector research funding**

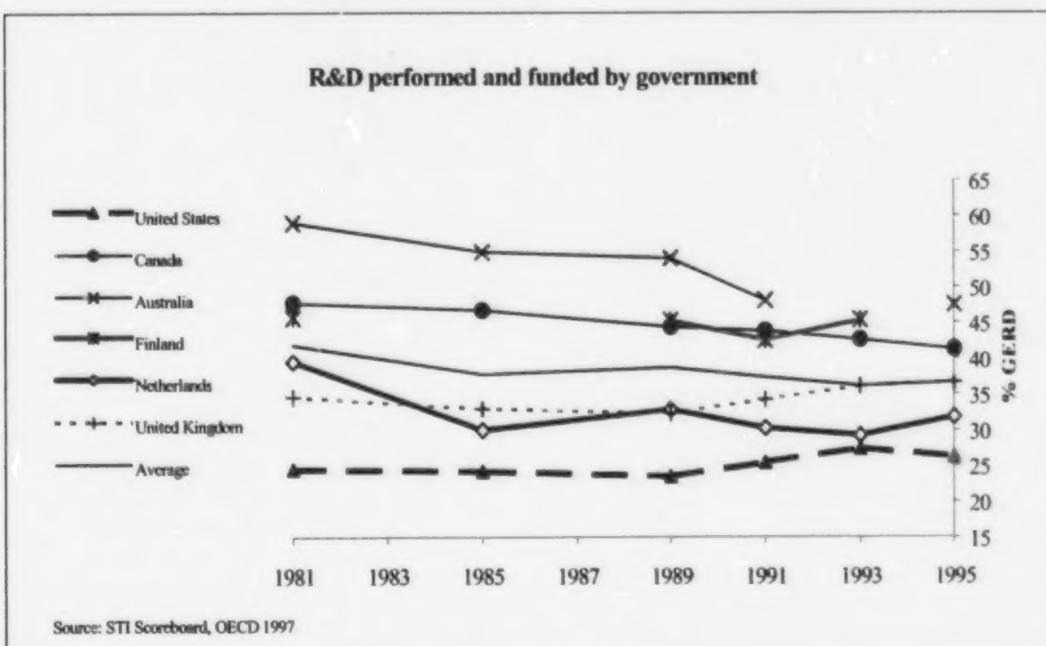


**Figure 2-2: Percentage of funds spent on government R&D**

**Box 2-1: Benefits of publicly funded (including government performed) S&T**

The following outlines six main forms of economic benefits from publicly funded basic research as reported in a recent review by the Science Policy Research Unit (SPRU).[1]

1. **Basic research as a source of new useful information**
   New useful information is the sustenance of the public-good rationale for supporting basic research.
2. **The creation of new instrumentation and methodologies by basic researchers**
   Scientific instruments have been described as the capital goods of the research industry. Economic and social benefits from the transfer of such equipment to industry can be significant as in the case of computers, nuclear magnetic resonance imaging, and more recently phase-shifted lithography technique used to produce etchings on silicon chips.[2]
3. **Skills developed by those engaged in basic research (especially graduate students)**
   The transfer of knowledge occurring when researchers carry codified and tacit knowledge from basic research to industry can lead to substantial economic benefits. Part of such knowledge includes knowing where to find information when knowledge is lacking in a particular area.
4. **Participation in basic research to gain access to networks of experts and information**
   Participation is particularly relevant in order to gain access to international R&D developments. Without ongoing participation, users loose acquaintance with advances in knowledge and subsequently lessen their ability to profit from them (this is known as 'absorptive capacity'). This 'entry-ticket' argument refutes fears that countries that do not fund their own research are given a 'free-ride' from the research of others.
5. **Those trained in basic research may be particularly good at solving complex technological problems**
   Having researchers available to solve complex problems often proves of great benefit in industry.
6. **The creation of *spin-off* companies**
   Spin-off companies created from a transfer of skills, tacit knowledge and problem-solving abilities to a commercial environment, is reported to be the least important of the six economic benefits identified.

The study concluded that, despite the highly flawed quantification methods, *publicly funded research appears to have a substantial impact on productivity* and that this trend is likely to continue given that new technologies increasingly rely on recent advances in basic research.

### *2.1.2 Globalization*

Distinguished by intensifying international competition, increased trade and investment and burgeoning co-operation among firms, globalization is very much responsible for the reorientation of worldwide production. Given the close interaction between globalization and improvements in information technology, closer global interaction invariably affects the innovation systems of countries. For example, according to the OECD, increased international competition is encouraging companies to improve the efficiency of their R&D and shorten their R&D time horizons, leading many to rely on the public sector for long-term R&D.

Such ***increasing dependency on the science system*** is evident from a recent patent study in the US showing that 70% of US patents filed in 1993-94 originate in public science.[3] This growing dependence is supported further from a study that found the number of publications cited in US

1 Martin, Salter et al. (1996). The Relationship Between Publicly Funded Basic Research and Economic Performance, *A SPRU Review*,

2 Rosenberg N. Exploring the Black Box: Technology, History and Economics, Cambridge University Press, p. 257.

3 OECD (1998). Science, Technology and Industry Outlook, Parisp.57

patents from 1987 to 1994 increased by a factor of three showing that ***new innovations are more and more reliant on advances in the scientific knowledge base***.[4]

Adding to the testimony for the effects of globalization are the growing number of programs encouraging co-operation between industry, universities and government S&T establishments in most countries. In the US for instance, the number of new co-operative R&D agreements (CRADAs) executed by agencies doubled from 502 in 1992 to 1003 in 1995.

Concurrent to the growing dependency on the science system has been the ***internationalization of the innovation process*** where firms set up R&D labs outside of their home country or engage in joint ventures with companies in different countries. The impact this trend has on government S&T depends on the extent to which governments are willing to extend their collaborative agreements to programs that involve foreign companies. Indeed, in an environment of perceived national competitiveness, such concerns have prompted some Americans to call for restricting free dissemination of research results from national laboratories and universities when reciprocity is felt to be lacking.[5]

**Foreign access to R&D programmes**

Yet despite such fears, collaborations between government, S&T establishments, and foreign industry, are on the rise. Of the 500 CRADA signed between 1986 and 1997 with the National Institute of Science and Technology (NIST) in the US, 47 involved foreign firms or their subsidiaries. In Europe, in addition to EU collaboration initiatives such as EUREKA[6], foreign companies involve themselves in national initiatives (includes involvement of public S&T institutes) such as the UK LINK program, albeit with strings attached. The Business-Oriented Technological Co-operation (BTS) in the Netherlands allows only those foreign companies with an R&D or production presence in the country to participate, provided that they can ensure that subsequent exploitation will occur within their borders.[7]

If the move towards regional trade block R&D initiatives, like the EU's EUREKA program, spread to other trade blocs such as NAFTA and MERCOSUR, Skolnikoff (1995) argues that national R&D policy will increasingly take into account regional economic, trade, and co-operation opportunities.

### *2.1.3 Technical Change*

Technical change, especially in information technology (IT), is having a profound impact on the science system not only in terms of structure but also productivity. Given its reciprocity with globalisation, the effects of technical change in IT on the structural organisation of science have been similar, namely ***increased collaborations*** made possible by computer networks. Through

4 Narin F, et al. (1997). "The Increasing Linkage Between US Technology Policy and Public Science.", research Policy 26, .p.317-330.

[5] Skolnikoff EB, Evolving US science and technology policy in a changing international environment, *Science and Public Policy*, April 1995.

[6] EUREKA supports near-market technology projects that include at least two of its 25 member countries.

[7] OECD, Foreign Access to Technology Programmes, 1997, Paris, 60493.

sharing data, information and ideas, scientists can focus on their research irrespective of where they are and allow for more ***interdisciplinary research***, a growing trend despite a concurrent tendency towards more concentration. This new level of co-operation has given sustenance to the concept of the ***virtual laboratory*** where large projects can be co-ordinated in a highly decentralised manner with extensive resource sharing.

As significant to such organisational innovations have been the improvements in the productivity of the science system. Advances in computer technology, for example, have significantly pushed the boundaries of understanding through the rapid processing of data required in such simulations of the climate and molecular reactions. Accompanying this increase in understanding, has been a ***decrease in time horizons for creating new knowledge***. The miniaturisation of scientific instruments (partly the consequence of IT improvements) is for instance, allowing entire scientific processes to be incorporated on a single microchip, reducing their time by orders of magnitude.[8] Scientific productivity has also benefited from advances in computers and related software allowing ***more*** science related activities ***to be done with less*** equipment and money. Data collection procedures, which often involved various amplifiers, sensors, and other such benchtop instruments, can now be replaced with computer programs and a multi-purpose workstation, dispensing with what were once costly apparatus.

Unsurprisingly, all these technical changes in scientific instruments have led to a ***burgeoning of scientific knowledge***, a proliferation of specialised scientific journals, and, unavoidably, increasing cost. The current move towards ***electronic publishing*** accompanying the increase in knowledge, will accelerate further the communication of results while broadening access to the knowledge through information networks and the planned digital libraries. Whether such publishing will alleviate the costs incurred by libraries and S&T establishments in gaining access to the information remains to be seen.

### *2.1.4 Personnel*

Of the several human resources problems facing government S&T establishments, an ageing of the scientific workforce is perhaps one of the more serious. With a significant portion of the scientists hired three decades ago nearing retirement within the next ten years, governments are now taking measures to facilitate the transition. In North America, the situation has been aggravated further by a slowing in the number of foreign students coming from Asia.[9]

In some countries, a disparity between supply and demand of highly qualified personnel is growing due to diverging development rates of certain scientific disciplines. Complicated further by 'headhunting' of top talent by not only industry but other countries as well, recruiting and retaining scientists has become a challenge especially for smaller countries such as Australia, Canada and the Netherlands. Adding to these problems is the growing disinterest shown by the younger generation in several scientific disciplines such as physics and chemistry, but not however in areas such as computer science.

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[8] The GeneChip, developed by Affymetrix, allows DNA sequence identification to be carried out in an hour rather than the traditional days-months process involving gels, glass plates and electric charges. (Source: The Global Research Village: How Information and Communication Technologies affect the Science System, OECD 1998)

[9] OECD (1998), Technology, Productivity and Job Creation - Best Policy Practices, Paris, p.155.

Yet for all the difficulties in retaining staff, both government laboratories and universities in many countries continue to offer poor working conditions to young scientists. This has led to, in the words of an OECD paper, "large contingents of high-level researchers... 'floating' in search of temporary positions in laboratories".[10]

## 2.2 Government responses

How governments and their S&T establishments respond to the global changes largely depends on what role they perceive themselves to have in supporting science and technology. An OECD report[11] points out that governments have essentially ***two basic roles*** in developing the science base:

1. Providing appropriate financial support to scientific research such that long-term research can be sustained which would not otherwise be carried out by the private sector. Such support also involves deciding on the correct balance between mission-oriented and non-oriented / curiosity-driven research.

2. Improving the interfaces between science and industry. Given the diverging motivations (knowledge versus profit), governments should encourage communication between the two 'worlds' by removing barriers to co-operation, support collaboration initiatives and facilitate the mobility of S&T personnel.

Complementing these two main roles are the government's societal responsibilities that invariably influence the direction of government S&T establishments such as:

- Influencing the orientation of research efforts towards societal needs.
- Accommodating the trend for increasing international S&T co-operation.
- Make adjustments to the S&T education and training system to prepare for potential shortfalls caused by a rapidly ageing work force.

Fulfilling these roles has elicited a variety of responses by governments as each search for the optimum balance that bests suits their culture, economic structure and national innovation system.

### 2.2.1 Financing models of government S&T establishments

In response to a reduction in financial support, government S&T establishments have adopted several models to varying degrees, each of which is described below. Although these models have posed significant managerial and ideological challenges through their public-private sector arrangements, the benefits, according to a recent US study, appear to be worthwhile (Box 2-2).

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[10] OECD (1998), Technology, Productivity and Job Creation - Best Policy Practices, Paris, p.155.
[11] *Ibid.*, p. 144.

**Box 2-2: Benefits of government – industry partnerships**

For all the ideological and managerial problems created from partnerships with the private sector, the benefits appear to make the challenges worthwhile. In a recent review of industrial partnerships in the US (Hill 1998), an overall 'spirit of excitement' was sensed among those labs who collaborated with industry, creating a 'business culture' which facilitated technology transfer and commercialisation of research results. Among the conclusions made in the study were:

- Informal co-operation between laboratories and firms can is some cases prove more effective since such co-operation can be entered into quickly and without the approval of management or agencies;
- Several rural based laboratories found that partnerships focusing on regional industrial needs is an effective strategy;
- Effective partnering must be clearly related to the laboratory's mission and core competencies; and
- Laboratories should recognize that not all potential partnerships are appropriate.

### Privatization

The UK, where a 1993 White Paper identified 15 laboratories that were to recover all their costs, is the only country reviewed to move towards complete privatisation of what are currently government S&T establishments.

### Commercialization

Encouraging public institutes to develop spin-off technology or become more directly involved in commercialization projects with companies has led to charges by the private sector in the Netherlands of unfair competition.

One issue currently dominating S&T policy discussions in Australia is proposed changes to the tax structure which would provide better incentives for government S&T establishments to create spin-off companies.

### Outsourcing

Outsourcing, whereby government research establishments contract out large-scale research programs or projects, does not yet appear to be a trend among the European nations. In the US however, government laboratories are currently being encouraged to have companies take responsibility for managing day-to-day affairs.

### Cost recovery

All countries encourage cost recovery to some degree. Several of the large Australian institutes, for example, have earning targets as a percentage of their total annual budget. In the Netherlands, the strain experienced from the pressure to recover costs while providing 'public goods' has lead to recent discussions on whether to force research institutes to transform into either a market-oriented or research-oriented organization.

**Contracting out research**

The contracting out of research other than to universities does not appear to be on the increase. Reasons for this are mainly due to the lack of private sector research organization in countries such as Australia, the Netherlands and Finland.

## *2.2.2 Improved partnerships and linkages*

Collaborations between federal labs and industry continue to be popular with policy makers who, under financial pressures, seek to better integrate government S&T establishments into the national innovation system, thereby getting added value from government S&T. In all countries, and especially in Australia and the UK, the strengthening of linkages between the public and private sectors has been accompanied with a move towards the partial to full commercialisation of S&T establishments, and contract-based competitive supply. In the US, there have been discussions to extend the partnership emphasis to universities as well to industry. Such collaborations with federal labs have proven successful where 'natural synergies' exist between the scientific mission and mission-driven activities, as in the case of nuclear and high-energy physics.[12]

**International co-operation**

The increase in international collaborations has been equally pronounced. As a way of avoiding duplication of expensive facilities and saving resources, collaborations with other countries have become policy objectives in Australia, Finland and the United States. As longstanding members of the EU, the Netherlands and the UK are well accustomed to collaborating through such programs as COST (Co-operation in Science and Technology Program) and subsequently no longer regard internationalisation as an issue. What has become an issue though in the Netherlands, is whether the country should share institutes rather than support their own institutes in all areas.

Although partly the result of an ever increasing number of science issues being of a global nature, such as climate change, the drive towards international co-operation has been accelerated with improved computer networks. Facilitating the sharing of data, information and ideas, such networks allow scientists to focus on their research irrespective of where they are, and carry-out more interdisciplinary research. (Some 26 percent of all scientific articles published between 1988 and 1993 were internationally co-authored.) Appropriately called the virtual laboratory, this new level of co-operation can be co-ordinated in a highly decentralised manner with extensive resource sharing.

## *2.2.3 Setting national S&T priorities*

Following the end of the cold war, several countries have experienced difficulties setting funding priorities for science (OECD). Financial accountability and the focusing of government S&T

[12] Shank C, A View of Research in the Future and the Role of the Federal Laboratories, National Science Foundation, 1998. www.nsf.gov/pubs/1998/nsb97150/shank.htm.

establishments with mission statements, however, has forced countries to have such priorities in order justify choices in R&D expenditure. To deal with the problem most of the countries reviewed have embarked on some form of foresight program with varying degrees of success. In highly pluralistic S&T systems such as in Australia and the US, such long-range prioritising programs have run into problems. In the more centralised UK system, however, the technology foresight program has, with some adjustments to their institutional frameworks, become an integral decision tool.

**Foresight and critical technologies**

The spread of technology foresight programmes throughout Europe and into the US and Australia, is indicative of the growing expectations for R&D benefits and increased pressure put on governments to account for the money spent. By bringing together industry, the scientific community, and governments to consider longer-term economic and social needs, as well as scientific and technological opportunities, technology foresight programmes have been used to establish priorities for funding technological research, to promote the uptake of 'key' technologies (France), and promote networking between industry and the science base (UK, Netherlands).

Among the many definitions of the notion, technology foresight can be described as "a systematic means of assessing those scientific and technological developments that could have a strong influence on the polity and its future development."[13] By portraying future possibilities rather than probabilities, the foresight process' usefulness comes not from predicting the future, but rather through informing participants, which includes both collaborators and competitors, what opportunities are likely to emerge in the future.

The use of foresight in influencing S&T policy began with Japan that, since 1971, has been preparing 30-year Technology Forecast Surveys using the Delphi approach (Box 2-3) to identify trends in technological innovation. Although foresight methodologies do vary by country, the two most widely used approaches are the Delphi survey and the critical technology approach, such as is done in the US, Germany and France. Both approaches involve substantial consultations with industry.

The degree to which the foresight results influence government policy varies. In the UK, results are used in policy and spending decisions across government, and underpin many of the collaborative research decisions of the LINK program. On the other hand, critical technology lists in the US seem to have had little or no impact in policy decisions.[14] In Australia, the foresight program did not survive the change of government which decommissioned the advisory body responsible for the program, the Australian Science, Engineering Technology Council (ASTEC) in mid 1998.

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[13] Loveridge D, Foresight and Delphi Processes as Information Sources for Scenario Planning.

[14] Industry Commission on Research and Development, 1995, p.884. Main groupings of critical technology lists normally include advanced materials, nanotechnology, microelectronics, photonics, microsystems engineering, software and simulation, molecular electronics, cell biotechnology and production engineering.

***Box 2-3: Foresight Methodologies***

**Delphi Approach**
Developed by the RAND Corporation in the 1950's, the Delphi survey aggregates expert opinion on future development trends within their respective fields. Once the first surveys have been completed and summarised, results are sent out in a second round allowing respondents to modify their earlier response and provide second thoughts.

**Critical Technology Approach**
The critical technology approach normally involves grouping together experts from various fields to select, through a structured process of group-based analysis, generic technologies of national relevance in the upcoming decade.

**Scenario Planning**
Through workshops-style meetings, plausible visions of future developments are drawn up, identifying key factors in determining how these visions would transpire.

### *2.2.4 Mission-oriented science*

Focusing the efforts of scientists towards problems of national significance has become the common *modus operandi* of government S&T establishments. In the US, such a 'mission-oriented' approach is used in all 736 national laboratories leading researchers to work in teams. Recently, under pressure to balance the federal budget by the year 2002, U.S. national laboratories have been asked to further streamline and focus their missions. The Netherlands and Finland each have various technological institutes geared towards mission-oriented research.

Following on the recommendations of the 1993 White Paper, the UK reorganised the Research Councils giving each a mission statement that would reflect the need to "harness our strengths in science, engineering and technology to the creation of wealth and quality of life."

### *2.2.5 Personnel*

An ageing scientific workforce, combined with declining interest in some fields of science, and excesses of personnel in areas which suffered government cutbacks, have put the future availability of well-trained researchers on the discussion table, especially in the smaller countries (Finland, Australia and the Netherlands) which must take measures to encourage staff to stay not only in the private sector but also in the country. In general though, most countries saw a decline in the number of researchers employed in government S&T establishments (Figure 2-3).

In Finland where discrepancies between public and private sector salaries are insignificant, there are no concerns about a 'brain drain' to industry, despite overall shortages in such areas as electronics. In the Netherlands and Australia, where such discrepancy do encourage personnel to leave for industry, salaries have been awarded at levels considerably higher than the standard civil service pay scale. Going one step further, the Netherlands has provided career development incentives by appointing more young people to higher positions.

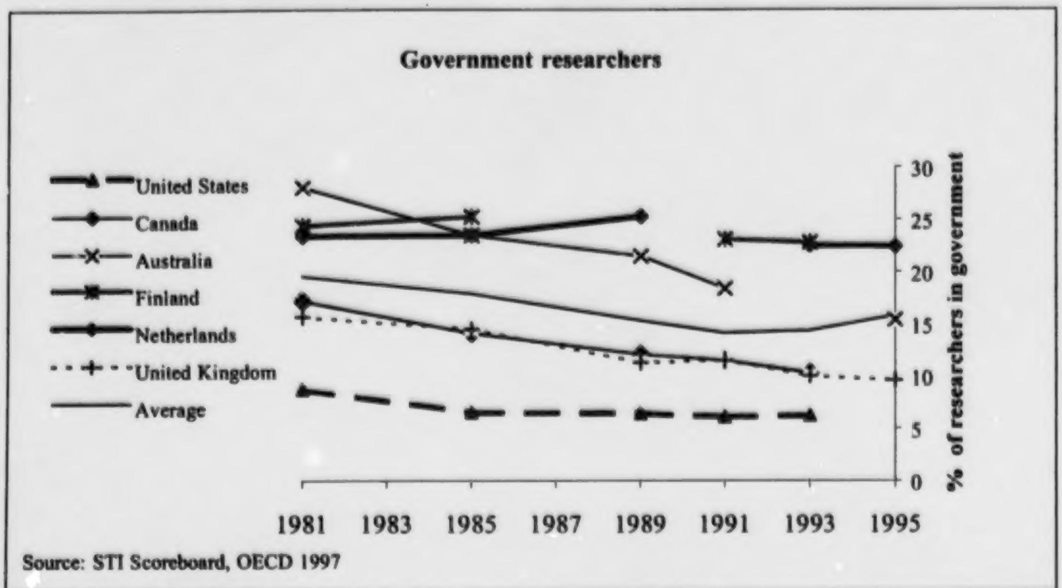



**Figure 2-3: Trends in the number of government researchers**

## 2.3 *Conclusions*

The forces bringing change to government S&T establishments are numerous and very much interrelated not only to each other but also to the responses they provoke. As an example, the calls for fiscal restraint were partly a necessary reaction to prolonged recessions and to the shifting of scientific priorities following the end of the Cold War. The budget cuts that ensued, (themselves a response to the current politico-economic environment) became a force of change to the entire organizational structure of the science system. Given such complexity, the major forces identified in this review, fiscal restraint and accountability, globalisation, technical change and personnel are but a sample of the forces affecting the science system. They nonetheless categorises the major factors having a direct bearing on government performed S&T.

The most common trend among countries has been the financial and managerial restructuring of government S&T establishments driven by the push towards self-financing. To varying degrees, countries have reoriented their institutes to act as service providers to industry, government agencies and local communities in an effort to leverage their funding duties to S&T in a rapidly evolving economic environment. Accompanying such adaptations have been efforts to focus the research of these establishments with mission statements that tie into national priorities, an endeavour made all the more difficult in the absence of national security priorities following the end of the cold war.

These responses, however, have not been without their share of negative impacts. According to the OECD, the financial restructuring of public S&T institutes have "disproportionally reduced the volume of research and related services of a collective nature provided by the economy."[15]

Also, the growing awareness of the importance of S&T to economic growth and the rising expectations of returns on public R&D investment, is effectively encouraging more of the scientific curriculum to be shaped by economic and industrial interests. Organizational innovations that encourage scientists to accept commercial funding for their research can be faced with conflicts of interest. Evidence to this effect has been found in a recent study (New England Journal of Medicine 1998, 338:101-6) which showed that research funded by the pharmaceutical industry is significantly more favourable towards the customer's products than is independently funded research.[16]

Included in the roles of federal science and technology departments and agencies are the following[17]:

- Ensuring the health and safety of the nation.
- Providing for the defence of the nation.
- Conducting applied research.
- Supporting basic science and the acquisition of knowledge.
- Providing support to industry and promoting regional economic development.
- Coordinating and participating in international cooperation.
- Providing a system of standards and regulations.

Table 2-2 summarizes the international trends in these roles.

## *2.4 Implications for Canada*

Canada has experimented with or considered most if not all of the trends observed in the five countries. What is more, Canada has in some cases taken the lead in adapting to the global changes as made evident by the fact that the newly established Dutch Innovation Centres were based on The Canadian Networks of Centres of Excellence program.[18] What then do international trends have to say for government performed S&T in Canada?

If there is a main point to be made from the foreign experiences it is that government responses are contingent not only on the country's national innovation system but also on its economic structure, historical precedents and cultural values. What has worked well for one country's public S&T institutes has not necessarily worked at all in others, as is evident from the experiments with technology foresight programs used to guide S&T priorities at a national level. Indeed, Finland, where public support for the sciences is high and wage disparities between

[15] OECD (1998), Technology, Productivity and Job Creation - Best Policy Practices, Paris, p.146.

[16] Cited from Professor Arthur Schafer's letter to The Globe and Mail, titled *Medicine morals and money, December, 1998*

[17] Industry Canada, "Government Science and Technology: An Overview of Federal S&T Performance", Draft, February 26, 1999.

[18] Interview with Luc Soete of MERIT.

public and private sector low, can address S&T problems from an entirely different approach (raise R&D spending) to countries like Canada where more caution is observed towards public involvement in S&T.

**Table 2-2: Trends in the Roles of Government**

| *Role* | *CA* | *AU* | *FI* | *NL* | *UK* | *US* |
|---|---|---|---|---|---|---|
| **Health** | ⬆ | ▲ | ▲ | ▽ | ⬆ | ⬆ |
| **Defence** | ⇩ | ▽ | ▽ | ▽ | ⬇ | ⬇ |
| **Applied research** | ⬇ | ▲ | ⬆ | ⬇ | ▲ | ⬇ |
| **Basic research** | ▽ | ▽ | ▽ | ▲ | ▲ | ▲ |
| **Industrial Support** | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| **International Cooperation** | ▽ | ⇧ | ⇧ | ▲ | ▲ | ⇩⇧ |
| **Standards & Regulations** | ○ | ○ | ○ | ○ | ○ | ○ |

⇩ **Decreasing** ⬆ **Increasing** ▲ **Strong** ▽ **Weak** ○ **Unknown**

Yet the international experience is not without some valuable lessons. In Australia, for example, the lack of a long term S&T vision has allowed universities to cut various programs without considering the future implications to S&T personnel requirements. This has led to a lack of training in certain areas.

Also interesting are the recent discussions in the Netherlands on whether to force public institutes to choose between becoming market-oriented with no funding from the government or strictly research-oriented with full government support. Such debates have arisen in attempts to address the accusations by industry that research institutes are competing with the private sector.

Whether the move in the United States towards outsourcing the day-to-day runnings of government laboratories will encourage other countries to follow remains to be seen. Certainly the new administrative accountability requirements put forth in the 1993 Government Performance and Results Act (GPRA) will be relevant to countries such as Canada who are seeking ways to improve the performance of government performed S&T. Perhaps more important for Canada though is to ensure that its government S&T establishments continue to

adapt in an effort to, in the words of the OECD, "achieve an open and productive science system, where scientists world-wide can exchange research results."[19]

In summary, the implications for Canada of the international experience are the following:

- The forces and issues influencing the federal performance of science and technology are common among the nations studied. However, the responses differ considerably and depend on the history and structure of the nation's innovation system.
- Canada is relatively isolated in international awareness and cooperation compared to many nations. This situation has worsened as a result of public sector fiscal restraint in the last decade. Our innovation system would be significantly stronger if it were opened to the resources of the rest of the world.
- Most countries give considerably more attention to the study of science policy compared to Canada. Canada needs stronger, ongoing analysis of the forces and issues within the Canadian context and for Canada's particular objectives.
- Many countries have more of a mission orientation to their science and technology compared to Canada. This means developing integrated programs that have a clear vision and specific objectives. Federal science and technology performers are well placed to take the lead in such mission-oriented programs.
- While foresight programs have had mixed success in other countries, Canada could possibly benefit from giving these techniques more attention in order to provide more focus to federal science and technology performance.

[19] OECD (1998), Technology, Productivity and Job Creation - Best Policy Practices, Paris, p. 225.

# 3. Australia

## 3.1 Highlights

| | |
|---|---|
| ***Current issues*** | ▪ Changes to taxation system: capital gains tax structure & GST. |
| ***Reviews*** | ▪ Institutes reviewed separately. |
| ***Gaps*** | ▪ Multidisciplinary research.<br>▪ Use of the Co-operative Research Centre mechanism in 'public-good' research areas.<br>▪ Gaps in research and data collection are emerging from the processes of privatising former public utilities and exposing them to increased competition. |
| ***Financing models*** | ▪ Cost recovery with earning targets in selected institutes. |
| ***Priority setting*** | ▪ With new government, foresight process has been disbanded along with ASTEC.<br>▪ No clear S&T priorities. |
| ***Personnel*** | ▪ With salaries more competitive than in universities, government S&T establishments do not experience the same difficulties as universities in retaining staff. |

## 3.2 Background

The Australian government's role in performing S&T has been, and continues to be, significant. With close to half of the public sector research conducted within government departments and research agencies, Australia is the largest government performer in the group spending 47.5% of government-finance gross domestic expenditure (GERD) in the government sector in 1995. Driven by a demand for research that would not normally be carried out by other research performers, research agencies are often required to interact closely with the users of their findings, giving much of the research an applied focus. Divided into several sectors, federal research agencies establish their priorities through a pluralistic approach.

### 3.2.1 A brief history of government research agencies

Reasons for the government's continued influence in S&T can be traced back to the basic structure of the Australian economy. Through an abundance of land and little labour, Australians

were able to attain a high living standard mainly from the production and export of primary products such as wool, gold, and wheat. One estimate suggests that by the turn of the century, Australian GDP per head was 10- 30% higher than the United States.[20] Subsequently, its small population and high wages did little to cultivate a competitive manufacturing industry, leading to low levels of private sector R&D and a dependency on technological imports. The low level of technological sophistication continues to be a feature of the manufacturing sector to this day. Furthermore, in the tradition of what has been referred to as 'colonial socialism', the Australian government has typically been a significant contributor to business and social services, with the performance of research very much a part of its contribution.

Its primary research institution, CSIRO, was established in 1926 to serve the research needs of the agricultural sector. At a time when few private researchers outside universities were available, there were few alternatives for financing research through the private sector. Following World War II, the tradition of "colonial socialism", reasonable success in wartime planning, and the low level of technological sophistication, justified government's continued leadership in R&D.[21]

Current rationales for government intervention, outlined in the 1995 IC report, follow received international opinion whereby the government should only perform or fund research that promises a sufficiently high social payoff, and might not otherwise take place. Choosing which research topics ought to be pursued by government, and whether research agencies should be allowed to make such choices, is an ongoing S&T policy issue.

## *3.3 Government S&T performers*

Commonwealth research is carried out through nine agencies (Table 3-1), three of which (CSIRO, AIMS and ANSTO) are 'stand alone' agencies with their own boards. In addition to having different organizational structures, the research agencies vary in degree of autonomy, in their external earning targets and in the type of research carried out. Some, for example, have charters to do independent research while others undertake a policy role for their respective departments. CSIRO has the widest charter, allowing it to carrying out research in the same fields as the more specialised institutes.

[20] Gregory RG, The Australian Innovation System,p.328
[21] Gregory RG, The Australian Innovation System,p.328

**Table 3-1: Commonwealth Research Agencies (1994-95)**

| Agency | Annual Government Appropriation ($M) | Number of Staff | Earning Targets | External Income ($M) |
|---|---|---|---|---|
| Commonwealth Scientific and Industrial Research Organisation (CSIRO) | 456 | 7407 | 30% of income | 237 |
| Defence Science and Technology Organisation (DSTO) | 231 | 2600 | none | na |
| Australian Nuclear Science and Technology Organisation (ANSTO) | 68 | 851 | 30% of approp. | 27 |
| Antartic Division | 65 | 282 | nil | 2 |
| Australian Geological Survey Organisation (AGSO) | 55 | 522 | 25% of approp. | 6.9 |
| Bureau of Rural Science (BRS) | 23 | 182 | nil | 2.8 |
| Australian Bureau of Agricultural and Resource Economics (ABARE) | 16 | 278 | 30% of funds | 4 |
| Australian Institute of Marine Science (AIMS) | 14 | 147 | 30% of approp | 2 |
| Bureau of Industry Economics (BIE) | 3 | 67 | nil | 0.5 |

*Source:* 1995 Industry Commission review of R&D

## 3.4 Policy issues

### 3.4.1 Policy makers & priority Setting

Australian R&D priorities are established on a sectoral basis, with the reasoning that each sector is best suited to identify problems and allocate funds accordingly. This pluralistic approach effectively couples S&T activity to the goals and needs of each sector thereby allowing institutions to become more responsive to market signals from their users and beneficiaries. The resulting 'customer/contractor' principle allows the 'customer' to play a significant role in determining both direction and level of spending in their interest areas. Thus for example, a corporation too small to carry out their own research could request federal S&T establishments such as CSIRO to perform the desired R&D.

Within the last year the advisory body ASTEC (Australian Science, Technology and Engineering Council) was disbanded along with its foresight activities leaving Australia without any forward-looking advisory body. The subsequent lack of clear priorities is currently very much an issue as some universities, under financial pressure, are cutting back on certain areas creating gaps in the training of certain fields. In the new government, S&T issues are dealt with in the Cabinet through discussions with the Chief Scientist. Table 3-2 lists the Australian policy makers.

**Table 3-2: Summary of Australian S&T Policy Makers**

| Policy Body | Influence |
|---|---|
| Prime Minister's Science and Engineering Council (PMSEC) | Overall government science policy and priority setting |
| Co-ordination Committee on Science and Technology | Complement PMSEC, ensure coherency of policy, facilitate sharing of information about programs, policies etc. of departments and agencies |
| Office of the Chief Scientist | Provide policy advice, briefing and support directly to PM |
| Commonwealth Departments | Provide policy advice concerning matters within their own portfolio. All have role in policy implementation. |
| Parliamentary Joint Committee on Higher Education and Training | Reports investigating various areas of S&T system |
| Australian Industry and Technology Council | Forum for State and Commonwealth issues |

### *3.4.2 Funding trends*

Government initiatives to encourage more private sector R&D, and target government R&D toward national priorities, are part of its response to strong demand for changing the structure of economy so as to reduce dependency on the export of primary products.

**Funding Facts**

- The general consensus is that R&D should be more applicable to the market. Directed grants have increased as block funding has decreased.
- Despite a declining dominance in the rural sector over the last 30 years, Australia continues to spend three times the OECD average on agricultural R&D (1989).
- Having accounted for more than a quarter of the government research budget in the early 1970's, CSIRO share fell to 16 % by 1990.
- Royalties from CSIRO activities previously repaid to the government, now support their annual budget.

### *3.4.3 Partnership programs*

**Cooperative Research Centres**

Cooperative Research Centres (CRC) were established in 1990 in the attempt to link together top universities, government research agencies, and industry into an information network allowing for 'integrated collaborative research teams' and research consortia to work together irrespective of geographical location. The program's objectives[22] are to:

- Contribute to national objectives, including economic and social development, and the establishment of internationally competitive industry sectors through supporting long-term, high quality S&T research.

[22] 1995 Industry Commission report on Research and Development p.833

- Capture the benefits of research and strengthen links between research and its commercial and other applications.
- Promote Cupertino in research and thereby make more efficient use of resources in the national research effort by building centres of research concentration and strengthening research networks.
- Promote active involvement of researchers from outside the higher education system in educational activities.

Although no guidelines were given on priority setting, other than that social sciences would be included, programs are evaluated on five criteria[23]:

- The nature of, and commitment to, co-operative research.
- The quality of the research program and the capabilities of the researchers.
- The application of the research, including the significance of the economic or social benefits to Australia, the involvement and resource commitment of key user groups, and the commercialization strategy for research results.
- Education and training programs.
- Project viability and management skills.

## *3.5 Recent S&T reports*

### *3.5.1 The 1995 Industry Commissions Review of Research and Development*

Australia's Commonwealth science and technology has been the subject of many comprehensive reviews over the past few decades. CSIRO alone has undergone 10 major reviews examining its restructuring and re-orientations between the early 1970's and 1995. The most recent, the 1995 Industry Commission review of research and development, remains relevant and applicable to the current science and technology system, and forms the basis of several subsequent reports addressing issues in research and development. Several general policy recommendations made were:

- diversity should be encouraged;
- private incentives should be built on where possible;
- assistance schemes should be monitored and evaluated;
- research should be monitored and evaluated;
- assistance levels should be consistent in comparable circumstances;
- contestability should play a major role in funding R&D;
- Government's objectives and roles should be clear.

[23] Ibid. p. 836

### *3.5.2 1997 Priority Matters*

This report, prepared by the Chief Scientist is a response to the 1996 National Commission of Audit which reported that the national S&T structure is complicated and has led to a system which is inefficient, largely unaccountable and without a clear process for prioritising. The following are the recommendations made which affect government S&T establishments.

**On defining national priorities for science and technology**

- The government should articulate a preferred vision for Australia's development toward national goals in the spheres of economic and industry development, quality of the environment and social well-being;
- National-level identification of priorities should concentrate on the structural level. Thematic priorities should only be included when there is a very strong case that the objective or field of science concerned needs special attention.
- An early step in identifying national S&T priorities should be the gathering, analysis and publication of statistical and other information which presents Commonwealth allocation of resources against agreed structural and thematic priorities for science and technology. This work should then be repeated at regular intervals as part of a national S&T priorities cycle.

**Gaps and Overlaps**

- Overlaps in S&T effort need to be recognised as a necessary and desirable part of the S&T system
- Duplication of effort is best addressed through communication among working scientists, negotiation between researchers, funders and reviewers, and improved co-ordination mechanisms within and across portfolios.

**Within-portfolio advice and co-ordination**

- Each department with significant S&T responsibilities should establish a position of chief science advisor, or assign the duties of such an adviser to an appropriate existing position in the department.
- Each portfolio should ensure that it has a high-level co-ordination and consultation mechanism which regularly brings together the key portfolio science and technology players to: a) develop and refine their S&T strategic planning system and activities, b) ensure that S&T make their full contribution to achieving portfolio goals, and are properly supported by portfolio resources and, c) discuss issues of mutual interest.
- CSIRO, ANSTO and AIMS should prepare a single joint strategic plan, aimed at ensuring consistency and complementarity of research directions. The joint plan should be prepared in consultation with, and made widely available to, the diverse stakeholders of the three agencies.

# 4. Finland

## 4.1 Highlights

| | |
|---|---|
| *Current issues* | ▪ Promoting internationalisation of science.<br>▪ Maintaining high public R&D spending after election. |
| *Reviews* | ▪ No reviews since 1996 rise in R&D spending. |
| *Gaps* | ▪ Attempts to diversify R&D away from over-concentrated sectors. |
| *Financing models* | ▪ No discussions for further privatisation than what already exists. |
| *Priority setting* | ▪ Foresight at very general level, priorities established at subcouncil level on basis of national interests. |
| *Personnel* | ▪ Not an issue. |

## 4.2 Background

With a Northern climate, relatively low population density, and a resource-based economy, Finland shares much common ground with Canada, despite its significantly smaller economy. Relying heavily on such industries as paper making machinery and forestry-based exports, Finland has been following a similar direction to Canada in its effort to diversify the industrial economy and to provide the necessary infrastructure to expand into new technology markets. For the most part, the country has been successful; having developed an advanced technology industry and encouraged most Finnish firms to shift towards more technology-based areas. According to a 1996 OECD economic survey, Finland has been one of the most dynamic of the OECD countries with respect to research intensity, having doubled its research spending since 1975 to 2.4% of GDP in 1994.

For all its success however, Finnish R&D remains very much concentrated to a few sectors. As shown in Figure 4-1, the electronics sector is responsible for over half the expenditure, a result no doubt influenced by the telecommunications giant, Nokia.

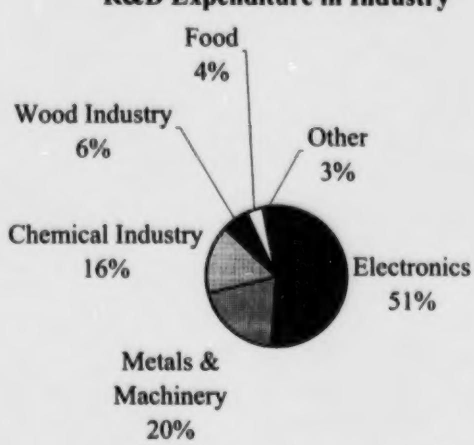



**Figure 4-1: Finnish industrial R&D by sector**

In the early 1990s, the national innovation system approach was adopted as basis for R&D policy, and remains so today. The 1996 decision to raise national research input to 2.9% of GDP by 1999 was done to strengthen the innovation system to support a diversifying industrial structure, knowledge-intensive growth in employment, and encourage the innovative capacity of firms. According to the Prime Minister, this shift, which has been financially supported by the privatization of state-owned companies, was described at the time as "the most important industrial policy decision the government has made."[24] The policy continues to receive widespread popular support from all groups in society, from the researchers to the trade unions, who have see it as a necessary step for Finland's future economic health.

## *4.3 Government S&T performers*

In 1992, amidst the recession, drastic restructuring was carried out which involved merging 34 laboratories into 9 research units. In place of internal boards, the new institutes require boards to include external members from industry and elsewhere. Figure 4-1 shows the new organisational structure listing the 21 institutes under their respective ministries.

24 Ormala E (1998) New Approaches in Technology Policy - The Finnish Example, STI Review, OECD No. 22, p.279.

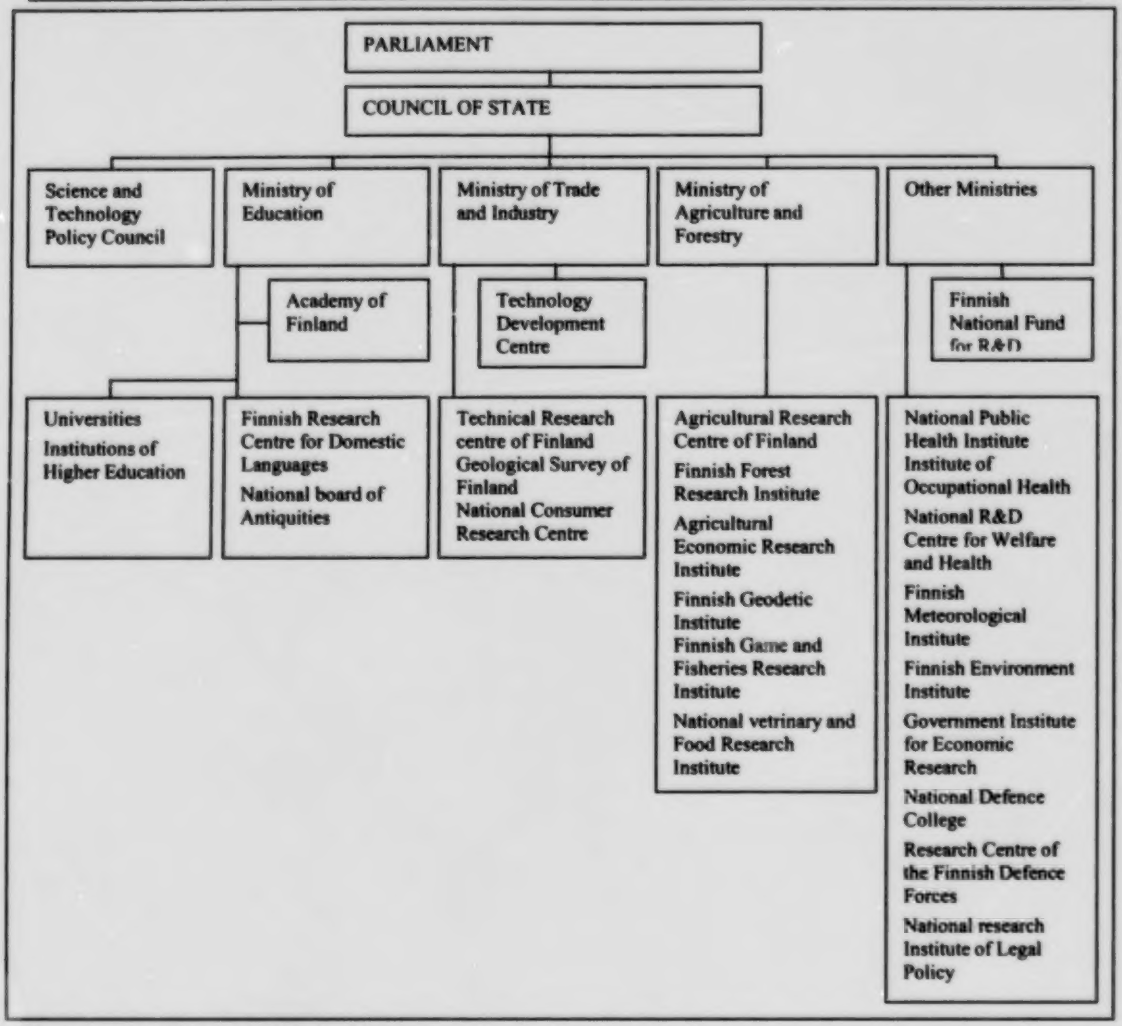



**Figure 4-2: Finnish S&T institutes**
(*Source: Academy of Finland*)

### *4.3.1 Technical Research Centre of Finland (VTT)*

Employing 2,747 staff, of which over half are in research, the VTT is the largest research institute in Finland. Through carrying out R&D, technology transfer and testing, the VTT is mandated to enhance the competitiveness of companies, to diversify the industrial economy and develop the societal infrastructure. In 1995 some 31% of its funding was earned through research contracts, up from 12% of the previous year.

### 4.3.2 Other

The 19 other institutes, which are considerably smaller in size, include the Geological Survey of Finland, 32% of which is funded through industry, the National Consumer Research Centre, the Information Society Research Centre, the Agricultural Research Centre of Finland (74% funded by government) and the Finnish Forest Research Institute.

## 4.4 Policy issues

### 4.4.1 Policy makers and priority setting

S&T policy is primarily the responsibility of the Ministry of Foreign Affairs, the Ministry of Trade and Industry, the Ministry of Agriculture and Forestry and the Ministry of Education. Advising on S&T related issues at the highest level is the Science Policy Council, a cabinet advisory body responsible for planning direction and co-ordination of research, and, in addition, acting as an adjunct to the Council of State and respective ministries. Much of the administration and financing is, however, carried out by the Academy of Finland, an association of seven research councils that finance, promote, co-ordinate and publish science activities. The science policy activities of the Academy are the responsibility of the Central Board of Research Councils which co-ordinates research initiatives across disciplinary lines.

The administrative equivalent to the Academy of Finland on the technology side is the Technology Development Centre, known as TEKES. Responsible for improving the technological base, TEKES' role is to finance applied technological R&D carried out in research institutes and universities, as well as to promote linkages between public research institutes and industry and support specific research projects in industry through loans and grants. Of the funds granted by TEKES, close to two thirds are allocated to the Technical Research Centre, with the universities and other institutes of higher education receiving roughly one quarter. The remaining funds go to joint venture research institutes owned by the private sector. At a ministerial level, TEKES contributes to central planning and co-ordination within the Ministry of Trade and Industry in the area of technological development.

Foresight as a tool to guide R&D priorities has been used, but at a very general level. The councils establish priorities after considering what are thought to be the most relevant areas of research for the national interest. Using the results of other country's foresight reports proved to be ineffective, according to Alpo Kuparinen, Director General of the Technology Policy Division. The academy's four sub-councils determine science priorities.

The new resources that were made available for basic research following the 1996 decision to increase R&D spending (mostly in applied research), were allocated through the Academy and earmarked for:

- Research programmes in strategic fields;
- Strengthening the centres of excellence in universities;
- Creating a system for post-doctoral education; and

- Encouraging further international scientific co-operation.

On the technology side, the main areas of emphasis have been in arctic technology, manufacturing technology, information technology, semiconductors, biotechnology and wood processing. Current programs focus on upgrading manufacturing technology in resource-based industries, construction-oriented research, and biotechnology, with priority given primarily to those programs showing possibilities for commercial exploitation. Technologically underdeveloped areas also receive funding, as well as 'urgent' research with a broad National appeal.[25]

The increase in funding for technology has been used to strengthen TEKES' main areas of activity such as technology programmes and product development funding, along with several other technological initiatives, including supporting the programmes conducted in regional competence centres, R&D projects in the services sector, cluster programmes[26] within the sectoral ministries, and efforts to raise the number of firms participating in R&D projects.

**Allocation of funds**

*New resources*
Since the policy decision to increase R&D spending, new money has been allocated to end-users in a competitive manner with the requirement to increase non-committed competitive funding. In addition, most of the funds have been directed towards technology, targeted research, and education, with some of the new money going to the sectoral ministries for 'cluster programmes'. Neither research institutes nor universities were given increases to their base funding.

*Special Research*
Drawing on a pool of funds provided by the Science Policy Council, administrations are able to commission their own research, one third of which normally goes to the ministerial research institutes. Similarly, ministries have also untied research appropriations used to finance research or studies as required. Prior to 1983, the Ministry of Trade and Industry was allocated the greatest portion of untied funds for use towards goal-oriented R&D programs considered relevant to national interests. Since then, the responsibility of supporting such R&D has been transferred within the ministry to the Technology Development Centre (TEKES).

### *4.4.2 Personnel*

Retaining quality staff in the research institutes is not yet a problem given the small discrepancy between public and private sector salaries. What is an issue generally - but does not seem to be affecting the government establishments - is the general shortage of qualified labour, especially

25 Cunningham P, Barker B, Eds., World Technology Policies, Longman Group, 1992, p. 728.
26 Cluster programs are designed to encourage co-operation between S&T organizations, industry and government with the aim of strengthen links betweeen innovation policy and other relevant policy sectors and create new opportunities. Cluster programmes operated in areas of telecommunication, foodstuff, transport, environment, forest and welfare.

in electronics and data processing where the multinationals such as Nokia have created a very large demand.

### *4.4.3 Internationalisation*

Encouraging internationalization in science has been an important focus, with international co-operative research programs tripling over the past 10 years. Much of this cooperation is through EU programs and members, although Finland is now redirecting its co-operative efforts to Japan and the United States who are leaders in areas important to Finland's national interests.

### *4.4.4 Partnership programs*

**Centres of Expertise program**

Established in 1994, the aim of the program is to 'facilitate the prerequisites for the location and development of internationally competitive enterprises which require a high degree of expertise" through enhancing collaboration between firms, the universities and research centres, the program supports.

**National Technology Programs**

Run through TEKES, these programs, which link together various industrial sectors and promote co-operation between industry, research and universities, support pre-competitive technology through building a knowledge base for further industrial R&D. Software technology, biodegradable polymers, machine vision are some examples of the types of technology involved.

## *4.5 Recent S&T reports*

The first major review this decade is due next year and will report on the performance of government S&T establishments following the major increase in funding in 1996. In the prior five-year period, Finland experienced both a major restructuring of the science system and a long recession, generating little in the way of significant S&T reviews until the 1996 review summarised below.

### *4.5.1 1996 - Finland: A Knowledge-Based Society*

This report prepared by the Science and Technology Policy Council following the Cabinet Economic Policy Committee's decision to raise research expenditure to 2.9% of GDP by 1999. The following conclusions and recommendations related to government performed S&T were made:

- Co-operation with other policy sectors must be further developed and deepened to improve knowledge utilisation;

- to further the development of the research system, networking and intensification of research competition must be encouraged, along with regular evaluations;
- the Technology Development Centre and the Technical Research Centre have a special task to strengthen the national knowledge-base of generic technologies on a permanent basis;
- the internationalisation of research environments needs to be promoted to stabilise research activities at a high international level;
- Interactions between research units with groups and Finnish society must be encouraged.

# 5. Netherlands

## 5.1 Highlights

| | |
|---|---|
| ***Current issues*** | ▪ Response of government to move by large multinationals towards shorter term research.<br>▪ Complaints of competition between public institutes and private sector. |
| ***Reviews*** | ▪ Emphasis on competition and encouraging innovation. |
| ***Gaps*** | ▪ Number of programs to spur innovation mark failure of public research institutes in co-operating with industry.<br>▪ Publicly funded research too far removed from market. |
| ***Financing models*** | ▪ Cost-recovery now common.<br>▪ Commercialization efforts bringing accusations of unfair competition.<br>▪ Very little if any outsourcing. |
| ***Priority setting*** | ▪ Public institutes receive lots of freedom, decisions made alongside annual budget, unclear where subsidies go. |
| ***Personnel*** | ▪ Higher pay scales keep researchers, more young people appointed to higher positions. |

## 5.2 Background

With 15 million inhabitants, the Netherlands is a small and densely populated country spending a total of 4 billion ECU on R&D in 1993. Of the 1.08% of GDP spent on private sector R&D, 46% was spent by the five largest multinational firms[27], making the technological position in the Netherlands very much affected by swings in overall company performance.

Having had to maintain a stable pattern of spending to conform to the Maastrict criteria, S&T policy has in the last few years little room of manoeuvre. Now however, under the direction of a new minister, all areas of science and technology are under review, the results of which are expected in a budget report come autumn.

A 1995 benchmarking exercise using standard performance indicators shows that performance in the public sector research system is doing well. With an output of 90 papers per 100,000 people,

[27] The five companies are: Shell (petrochemicals), Philips (electronics), Unilever (food), DSM and AKZO-Nobel (chemicals).

the Netherlands ranked second to Denmark, and in terms of influence, (as measured by number of citations in scientific journals) came second only to the United States. Yet for all its bibliometric success, there is considerable concern over the under-emphasis of near-market publicly funded research and a general lack of technological capabilities.

## 5.3 Government S&T performers

Outside of the universities, public research is carried out in eight major institutes, which are for the most part organized by research areas:

- Technological institutes (GTI)
- Energy Research Foundation (ECN)
- Delft Geotechnics Laboratory (GD)
- Netherlands Maritime Research Institute (MARIN)
- National Aerospace Laboratory (NLR)
- Delft Hydraulics Laboratory (WL)
- Organization for Agricultural Research (DLO)
- State Institute for Health and Environment (RIVM)
- Netherlands Organization for Scientific Research (NWO)
- Organization for Applied Scientific Research (TNO)
- Innovation Centres (IC's)

Apart from the NWO, whose main tasks are to contract-out research funds to universities on a competitive basis and to promote knowledge diffusion, all research performed in the institutions is intramural. A recent addition to the group of S&T establishments, is a network of 18 Innovation Centres (ICs) whose main role is to disseminate knowledge to SMEs.

Among the list of institutes, are semi-public organizations that operate in all areas of the knowledge chain, including basic research, mission-oriented research and consultancy work in the market. These institutes known as the Large Technological Institutes (LTIs) include the ECN, MARIN, GD, NLR, and the WL.

The TNO research institute consists of 16 institutes employing some 4500 staff with an annual turnover in 1994 of 346 million ECU. The institutes undertake primarily applied research for both government and industry. The TNO has typically been largely dependent on direct government funding, although changes are now under way to bring the research closer to the market and tie grants to business research projects.

With the trend towards greater commercialisation, research institutes do not yet contract out research. Although the contract-based competitive supply approach appears to be working - albeit with some difficulties (see report reviews below)- more time is needed for definitive conclusions.

## 5.4 Policy issues

### 5.4.1 Policy makers and priorities

Policy is formulated through three main bodies: the Ministry of Economic Affairs, whose main area of responsibility is S&T policy with regard to companies, the Ministry of Science, Education and Culture, which co-ordinates science policies of the different ministries and the Advisory Council on Science and Technology (AWT).

In addition to the AWT, which provides general advice either by request of the ministers or on its own initiative, are two other advisory bodies, the 'Forum for Science and Technology', a group of leading representatives from science and industry, and the Rathenau Foundation whose main area of responsibility is technology assessment.

The major GTIs operate under missions established in consultation with government and are normally geared towards national interests. As with most other major European countries, the Netherlands engages in foresight activities to support the identifying of these interests.

### 5.4.2 Funding

The Ministry of Economic Affairs (EZ) and the Ministry of Education, Culture and Science (OC&W) through their respective responsibilities for technology and science policy, together fund more than 70% of the total public R&D budget. Of the NGL 5.327 million spent in 1997 on R&D, academia received the most with 42.8% of the share followed by industry at 13.2% and basic research at 11.9%. The remaining fields, which include defence, agriculture, health, energy, space and infrastructure, each took less than 5% of the funding. Despite a decline in overall R&D spending throughout the 1990s to below the OECD average of 2.2 per cent of GDP, public R&D spending in the Netherlands has remained relatively stable.

### 5.4.3 Transparency

In an effort to reduce inefficient overlaps in the science system measures have been recently taken to improve overall transparency. Mission statements have been adjusted to minimise overlaps while ensuring that some inter-institutional competition remains so that universities generally provide scientific education and perform basic and strategic research and the TNO, DLO and five GTIs perform applied research for industry and other sectors of society.

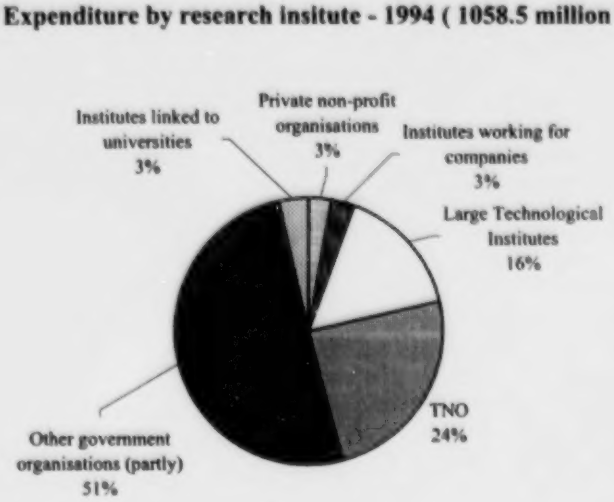



**Figure 5-1: R&D Expenditure in the Netherlands - technical sciences only.**
(*Source*: Monitoring Science and Technology Policy III, MERIT, 1997)

### *5.4.4 Partnership programs*

**National Technology Programs**

To improve co-ordination between different phases in the knowledge generating process, four national technology programs have been established to guide the support for research institutes (IOP -see below) and companies in the areas of materials, biotechnology, environmental technology and information technology.

**Stimuleringsregeling Innovatie Markt-en Concurrentiekracht**

In an effort to stimulate innovations in agriculture, fishery, forestry and environmental management, the responsible Ministry provides incentive-based subsidies for particular projects: if the innovative results are made public, the first 930 000 ECU are funded at 50 % with the remainder at 25%. If however, the results are not made public, only 25% of entire project is subsidised. The maximum amount subsidised is 1.17 million ECU.

**Innovation Research Programs (IOP)**

Along with targeting the funding of research institutes, IOPs contribute to the government's effort to stimulate collaborative research between companies, research organisations and universities. The eight-year programmes, which provide funds (mostly to universities) in areas

of the national technology program, have been successful in creating networks, although the Ministry of Economic Affairs has concluded that the programs need more flexibility and more attentive to the relationship between research results and the competitive position of Dutch industry.

**Subsidies for Sector Specific Centres for Technology**

To increase the amount of technological knowledge in SMEs, the Ministry of Economic Affairs has established centres to provide information, education and advice. The centres receive support of up of 50% or 467 000 ECU.

**Special Public-Private Projects (ICES)**

Public-private partnerships involving universities, research, and educational institutes, public departments and companies are supported to strengthen the technical infrastructure in areas of biotechnology, transport technology, land-water initiatives, subsoil engineering for roads and railways, high performance computing and networking and agricultural food processing.

## *5.5 Recent S&T reports*

Current Dutch S&T policy is based on two white papers, "Competing with Knowledge" (1993) and "Knowledge in Action" (1995), the latter of which saw most of its measures implemented by 1996. These measures, designed to increase the knowledge intensity of the Dutch economy include:

- Improving the conditions for innovation through financial support for R&D and tax credits for wage costs of researchers;
- Improving the co-ordination of supply and demand of knowledge through such initiatives as: encouraging collaboration between research institutes, firms and universities with targeted funding, making the research system more transparent to reduce overlap between institutes, and, involving business representatives in selection process of research programs (in return for financial support from the private sector);
- Creating two new types of leading research institutes by providing extra support to 10 existing university-based 'research schools' and establishing three to five 'leading technological institutes' to be largely supported by industry;
- Stimulating diffusion of new promising technologies through support of clusters;
- Support technologies with important economic and social benefits.

*Source: Monitoring Science and Technology Policy III, Merit, 1997*

### *5.5.1 A Vital Knowledge System: the Future of Dutch Research*

In 1992, the OCV (Foresight Steering Committee) was established to consult the researchers, as well as the businesses and public organizations that use their work, on the funding alternatives available in a wide range of scientific fields. The report, "A Vital Knowledge System: the Future

of Dutch Research", published in 1996, recommended that research focus on 12 'knowledge themes' and encourage multi-disciplinary research within six areas of science. Table 5-2 outlines these themes.

### 5.5.2 Table 5-1: Knowledge themes identified by 1996 OCV report

| Knowledge theme | Extent of government involvement |
|---|---|
| Information and communication infrastructure | Nature of support for ICT decided with the Cupertino of NWO |
| Education in a knowledge society | Major role to be played by the Educational Research Programme Council within NWO |
| Agriculture and the food industry | Aimed at sustainable agriculture and food production, the initiative will involve co-operation between several research institutes. |
| The services sector | Research to look at ways of improving productivity and growth should involve nearly all scientific disciplines and require co-operation between universities and the NWO |
| National research initiative 'Factor 4' | This initiative to reduce pollution by half while doubling the living standard will involve multi-disciplinary Cupertino and international partnering with neighbouring countries. |
| Integrated use of space | Considered one of the most important research topics in the next few years, especially with respect to transport. |
| Developing economic activity | Research will be concentrated on new-methods of knowledge intensive production. |
| International and regional change | Aimed at reinforcing the number of international comparative research topics as well as on methods of controlling international conflicts |
| Social cohesion | In response to lessening of Dutch social cohesion, the NWO will look into regenerating solidarity within society. |
| Health research | Initiatives will focus on 'quality of life', 'effectiveness of health care', ageing, and related diseases. |
| Global environmental issues | Main area of concern is Dutch participation in international research into 'Global Change'. |
| Energy research | Research should focus on making more efficient use of energy, materials, and renewable sources of energy. The initiative will involve cooperation between universities and the Netherlands Agency for Energy and the Environment. |

*Source*: Summary of Science Budget 1997, Ministry of Education, Culture and Science.

Research institutes are expected to accommodate these recommendations, along with the specific choices made by the Cabinet's science budget in their plans.

### 5.5.3 *The use of the large technological institutes*

Published in 1998, this study examined the role of the five large technological institutes (LTI) with budgets ranging from NLG 34 million at MARIN to NLG 139 million at NLR. The study looked at three main areas, each of which is summarized below:

**The significance of the LTIs as links between both fundamental research and applications & competition and collaborations**

The study found the linking role of LTIs to be limited, especially with respect to universities. Furthermore these institutes, which are primarily oriented towards developing there own technology, are becoming more commercialized (partly in reaction to government encouragement) and subsequently less concerned with their depth of expertise - and less worthy of government support. From study interviews, several felt competitive pressures from these subsidized laboratories, whereas the public sector has tended become more dependent on LTIs for knowledge and expertise.

Responding to these problems, the Advisory Council for Science and Technology Policy (AWT) concluded that LTIs should become more focused and no longer be allowed to operate in the entire knowledge chain from researchers to consultants in the market. The new recommendations would thus require institutes to become one type of organization or the other. Those that position themselves as research-oriented organizations would develop new knowledge and technologies, whereas those who choose the market-oriented organizational structure would be primarily involved in knowledge transfer.

**International Context**

Given the possibilities for greater efficiencies through closer collaboration with EU countries, the study concluded that those institutes orienting themselves towards research activities should, with the guidance of the government, be more involved internationally. The market-oriented organizations, however, would themselves be responsible for international collaborations, acting in the interest of the Dutch private sector.

**The responsibility of the government in administrative and financial relationships**

Under-funding for some of the tasks assigned by governments has forced LTIs to look to commercial support to augment their funding. This has prompted cries of unfair competition from third parties in both the public and private sector who see LTIs giving an unfair advantage to competitors. Furthermore, the knowledge originally acquired through public funds is subsequently restricted through collaborations with firms, undermining the rationale for their support.

The proposed solution of dividing institutions along market-oriented and research-oriented lines will require new responsibilities for government in determining when and how a desired mission should be funded.

# 6. United Kingdom

## 6.1 Highlights

| | |
|---|---|
| ***Current issues*** | ▪ Further privatisation of institutes and exploitation of results. |
| ***Reviews*** | ▪ Last major review was a 1993 White Paper, new White Paper expected soon, along with a major review on the commercialisation of public sector research establishments' research outputs (announced on 10 Feb. 1999). |
| ***Gaps*** | ▪ No information. |
| ***Financing models*** | ▪ Trend towards full privatisation of those institutes whose research areas are suited to regulation through market forces.<br>▪ 'Customer-contract' principle to be strengthened with departments. |
| ***Priority setting*** | ▪ Foresight, implemented in response to 1993 White Paper plays major role in focusing S&T efforts to matters of national importance. |
| ***Personnel*** | ▪ No information. |

## 6.2 Background

In the wake of Thatcherism in the 1980's where state monopolies were privatized, trade unions undermined, and direct taxation lessened, it is not too surprising that the UK should be the first to declare in a major policy statement that "privatization is a realistic prospect for a number of [government research] establishments."[28]

Making departmental laboratories more accountable is, however, by no means a new concept in the UK. In 1971 the report of Lord Rothchild recommended that a customer/contract relationship be set up in areas of government applied research. To encourage accountability, the report recommended that 25% of their budgets be transferred to departments that then purchase research from the councils as a customer. In the following year, a white paper was published recommending that scientists better justify their demands upon public resources adding further to the atmosphere for a tough fiscal environment which continues to characterise government S&T to this day.

[28] HMSO White Paper, Realising our Potential, 1993, p. 46.

This past decade as seen considerable restructuring at the advisory level with the establishment of the Office of Science and Technology, and at the research level with the introduction of 'new public management' approach. With the help of the new technology foresight program, the 1990's have also seen the directing of government S&T to areas of national importance.

## *6.3 Government S&T performers*

### *6.3.1 Research Councils*

The functions and funding roles vary considerably between each of the five research councils. Of the five, three perform their own research as their primary function in their own institutes (Agricultural and Food Council (AFC), Medical Research Council (MRC) and Natural Environment Research Council (NERC)), while the Economic and Social Research Council (ESRC) and the Science and Engineering Research Council (SERC) primarily allocate funding to higher education and independent research institutes. Although the SERC does support four of its own research institutes (Royal Greenwhich Observatory, Royal Observatory Edinburgh, Rutherford Appleton Laboratory and the Daresbury Laboratory), in terms of total expenditure, funding allocation remains its primary function. In terms of funding to the councils, 60% of the research carried out is basic, with the remaining funds supporting primarily applied research, with a small percentage in development (Figure 6-1). In terms of total R&D expenditure performed by government, research councils have seen an increase in the portion of funds received.

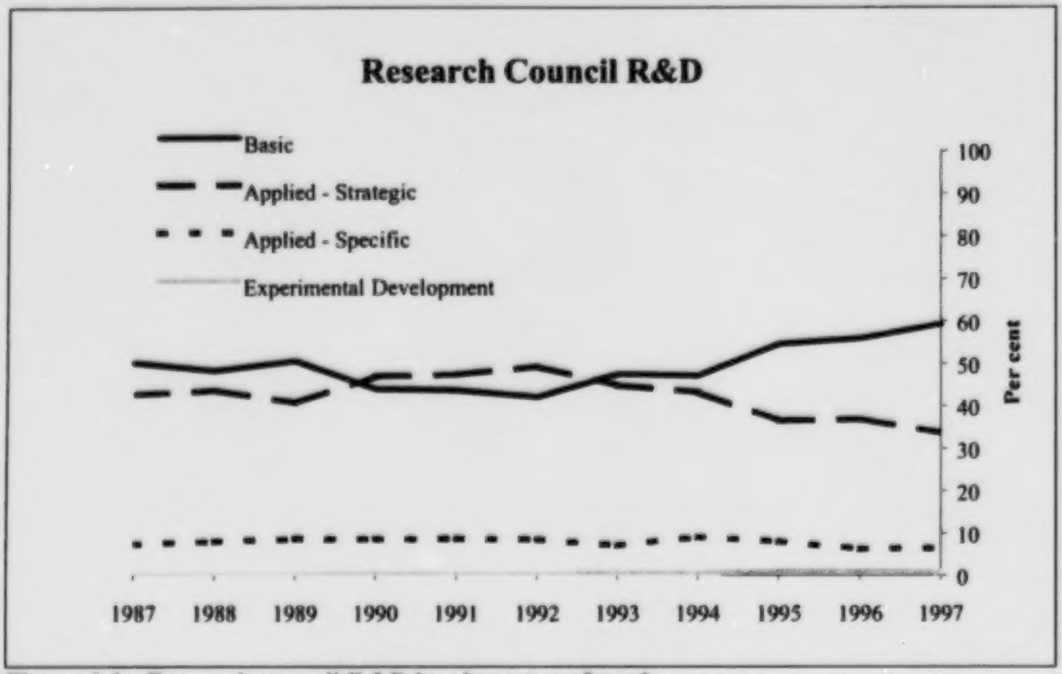



**Figure 6-1: Research council R&D by character of work**

### *6.3.2 Civil departments and agencies*

Research agencies affiliated with departments, which include the defence laboratories, perform most of the applied research and development work. As with the US, UK defence related R&D is both the most substantial component of government-funded R&D and has been in decline throughout the past decade (See Figure 6-2).

Measures taken to improve the customer-contractor relationship between agency and department were laid out in the White Paper:

Responsibility for commissioning research and development has generally been placed with the relevant policy divisions of Departments tapping into the intelligence built up by the Chief Scientists' groups and equivalent arrangements within Departments. These divisions hold a budget, which they use to implement their decisions on the research and development they need to meet their policy objectives. They draw up specifications and enter into contracts with the suppliers whom they judge can best deliver to specification. The divisions are expected to mount competitive tenders wherever practicable, and to seek value for money. In addition, Chief Scientists take a strategic overview of the contribution of science and technology policy development over both the long and short term.

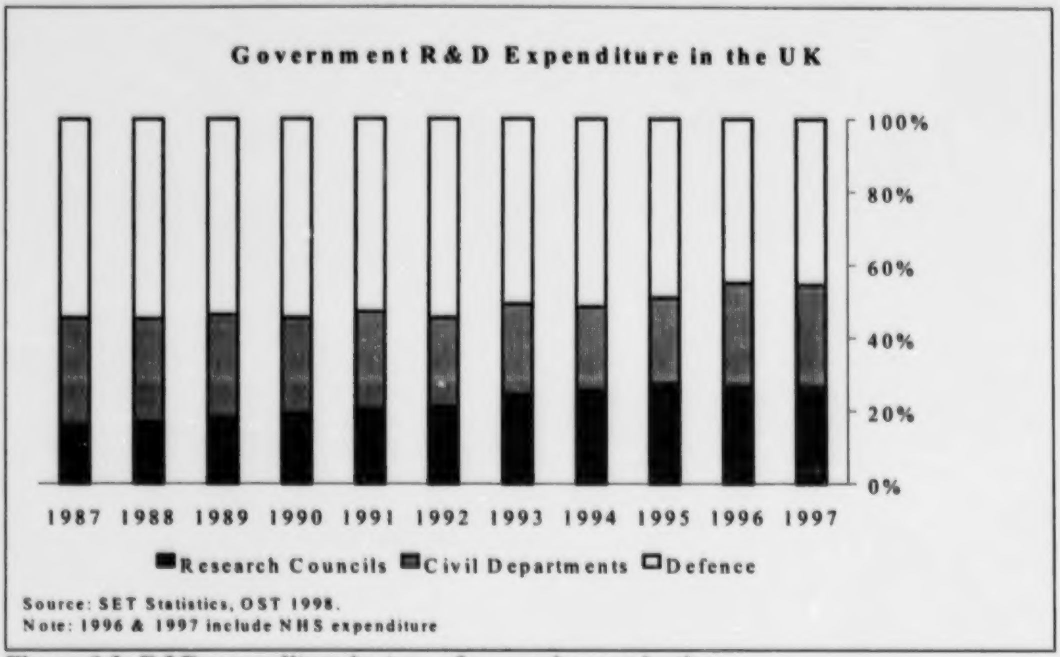



**Figure 6-2: R&D expenditure by type of research organization**

## *6.4 Policy issues*

### *6.4.1 Policy makers & priority setting*

As with the United States and Australia, UK S&T is pluralistic in its organization, although recent changes are a making this increasingly less so. With no unitary UK science policy in place, decisions in research are made *ad hoc* through consultation with committees and advisory panels. Table 6-1 provides an overview of the government bodies and their roles in formulating S&T policy. R&D programmes remain the responsibility of each departmental minister. Within civil research areas, the Advisory Council on Science and Technology and the Advisory Board for the Research Councils carry significant influence by providing confidential advice on departmental priorities (Council) and by advising on the allocation of funding (Board). Responsibilities for the R&D programmes lie with the minister of each respective department.

Following the recommendations in the 1993 White Paper, *Realising our Potential*, the UK began an extensive national-level foresight program covering all major sectors of the economy. The first set of results, released in 1995, are used to guide priorities by informing departments and Research Councils on how funds should be allocated.

**Table 6-1: Summary of UK S&T policy makers**

| | |
|---|---|
| **Cabinet and Prime Ministerial Level** | |
| Office of Science and Technology | • Headed by Chief Scientific Advisor who provides advice to the PM and the Cabinet, OSTP reviews entire research system |
| Advisory Council on Science and Technology – ACOST | • Provides the Cabinet with required information, contributes to policy implementation, and offers confidential advice on priorities |
| Advisory Board for the Research Councils (ABRC) | • Advises the Department of Education and Science on allocation of funding to the five research councils |
| **Parliament** | |
| House of Lords Select Committees | • Provide influential reports which must be responded to within six months by government |
| **Independent Advice** | |
| Science and Technology Assessment Office | • assess R&D expenditure throughout government and perform evaluations of research itself and its results |
| Parliamentary Office of Science and Technology (POST) | • performs technology assessments and look into complex issues arising in society as a result of S&T |

*Source*: World Technology Policies, Cunningham & Barker (1992)

### *6.4.2 Funding*

The most significant trend in funding is the privatization of S&T agencies. On the recommendations of the White Paper, 15 laboratories serving eight departments were to recover their costs from customer charges. These include the Central Science Laboratory, Central Veterinary Laboratory, Meteorological Office and the National Physical Laboratory. This customer-contract approach is being followed in defence areas as well, with the ministry making defence technologies more accessible for civilian use and promoting 'dual-use' defence technologies.

In terms of proportion of funds allocated, basic research has seen an increase at the expense of development, reflecting the decrease in defence R&D (Figure 6-4).

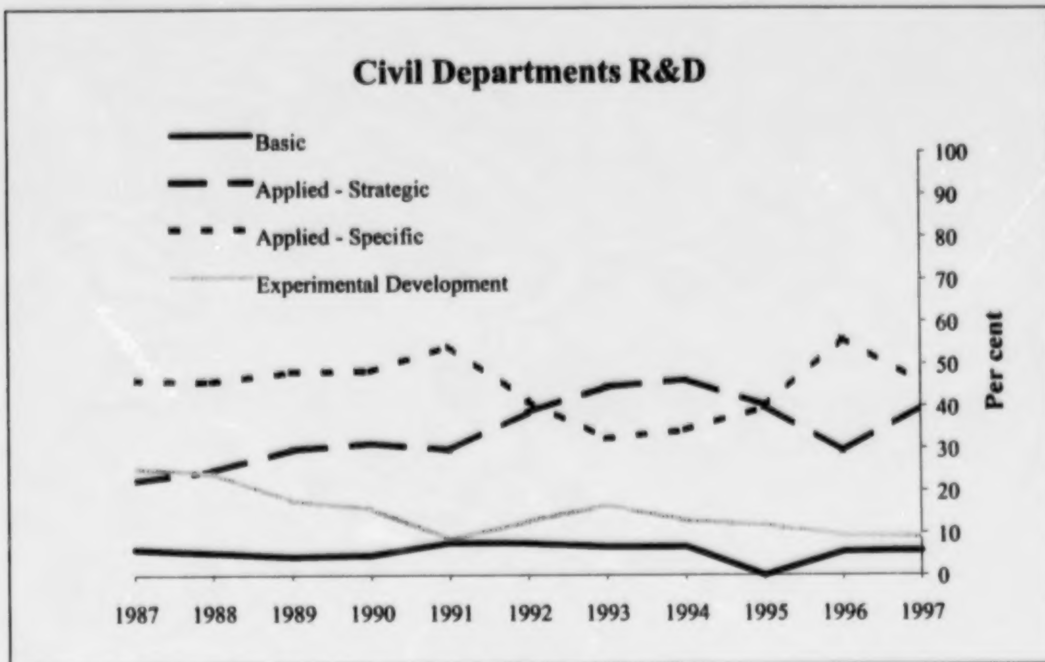



**Figure 6-3: R&D in civil departments by character of work**

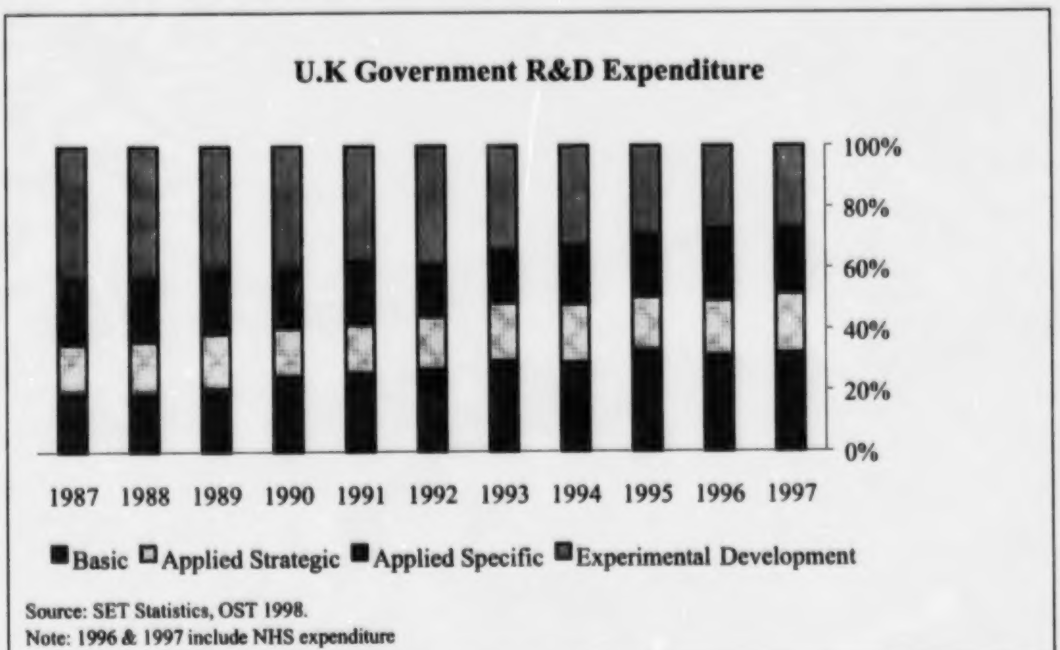



**Figure 6-4: Government funding by character of work**

### 6.4.3 Major partnership programs

The ***LINK Program*** supports pre-competitive R&D for early-stage technologies in areas of 'strategic importance' by promoting partnerships with research institutions and firms. The government funds up to of 50 percent of project expenses, with the balance provided by industry.

The ***Advanced Technology Programs*** (ATPs) are designed to assist and accelerate the development of key technologies, such as superconductivity, robotics, and advance information technology.

## 6.5 Recent S&T reports

**1988 White paper " DTI - the Department for Enterprise"**

This report re-focussed public R&D expenditure towards pre-competitive activities.

**1998 The Next Step Initiative**

Report introduced the 'new public management' approach to government research establishments and began debate on whether full privatisation was appropriate.

**1989 Advisory Board for Research Councils review of Research Councils' responsibility for biological sciences**

Recommended the reconstitution of the Research Councils as an autonomous National research Council, a review of the customer/contract principle and a reversal of the customer/contract principle in some cases. None were implemented.

**1993 White paper "Realising our Potential"**

The most recent major report of science and technology was the 1993 White Paper, *Realising our Potential*. This sweeping review affected public sector S&T through such initiatives as the technology foresight program, restructuring of the research councils, further privatisation and the focusing and co-ordinating of national funding and support programs. Although most of the recommendations were accepted, any changes to Research Council establishments were to be subject to prior options reviews which would address the relationship of the establishments to any others in similar or related fields. Some of the responses to the paper are listed below:

- Results from foresight program will inform government and other policy bodies on S&T funding.
- The Research Councils were reorganised into six councils each with a specified mission statement reflecting the stated need of "harnessing our strengths in science, engineering and technology to the creation of wealth and quality of life".
- Councils, each of which determines their respective areas of research with strategic influence, began to issue funding through two categories: *Directed-mode* and *Thematic-mode*. In both cases, those proposals judged to be of high quality by either a small group of peers qualify.

- Many of the scientific services carried out by government research establishments could be carried out by the public sector.
- Customer/contractor principle governing departmental applied R&D would be maintained and strengthened with departments continuing to develop their role as knowledgeable customers for science and technology. Competitive tendering would become standard procedure.

**1996 Forward Look**

Following directives in the White Paper, an annual report titled *Forward Look* began to be published that sets out the policy and plans for publicly funded S&T and summarises the programmes and activities of departments and Research Councils. The five main objectives identified by the 1996 *Forward Look* are presented below:

- To develop publicly funded science, engineering, and technology to meet the country's future needs, taking account of Technology Foresight, and fostering partnerships between the science and engineering base, industry and government.
- To maintain the excellence of UK science, engineering and technology, to advance knowledge, increase understanding and produce highly educated and trained people.
- To improve public awareness and understanding of S&T.
- To maximize the effectiveness of our EU and international collaboration in meeting UK objectives.
- To promote collaboration between government departments and ensure that trans-departmental S&T issues are handled effectively, while improving efficiency and value for money.

**Forthcoming reports**

A study of public sector research establishments (PSRE) was announced on February 10th 1999 to investigate the commercialisation of research and to make recommendations for improving commercialisation of results. In particular the study will investigate:

- The role of sponsor departments/Research Councils in promoting the exploitation of research in their PSREs;
- Progress in improving the culture of entrepreneurship with PSREs - particularly through the adoption of new guidance on exploiting Government assets;
- The organisational capacity and expertise for managing and exploiting government intellectual property effectively;
- Specific institutional barriers and possible new incentives
- Spreading best practices
- The scope for closer co-operation with the private sector.

A major review by the Policy Research Institute in Science, Engineering and Technology (PREST) on the *effects* of the new public management approach PSREs will be published in 1999.

# 7. United States

## 7.1 Highlights

| | |
|---|---|
| ***Current issues*** | ▪ Improving relevancy of government laboratories to departmental missions while reducing low priority programs.<br>▪ Experimenting with corporatisation of labs where private contractors are responsible for day-to-day operations.<br>▪ Government Performance and Results Act stressing performance plans, managerial flexibility and accountability. |
| ***Reviews*** | ▪ 1998 review by House Committee on Science gives recommendations for updating the national science policy.<br>▪ 1995 Federal laboratory review recommending ways to improve efficiency and effectiveness of laboratories. |
| ***Gaps*** | ▪ No information. |
| ***Financing models*** | ▪ Outsourcing of day-to-day operations to companies encouraged.<br>▪ Large increase up to 1995 in research collaborations with emphasis on technology transfer, although now evidence shows agencies to be backing away from such arrangements.<br>▪ Discussions on encouraging further co-operation between labs and universities. |
| ***Priority setting*** | ▪ Attempts are being made to better co-ordinate the highly pluralistic S&T system, critical technology lists have not been very influential. |
| ***Personnel*** | ▪ No data. |

## 7.2 Background

For the first time in 1997, the United States surpassed the $200 billion mark in R&D expenditure. Such an unprecedented sum is indeed what most strongly distinguishes US R&D from other countries, accounting for roughly 44 percent of the worldwide R&D investment. Those responsible for this upward trend in R&D expenditure are primarily the profit-making companies who, under strong international competition, record setting profits, and with the exploitation of information technology, have paid for two thirds of the total R&D.[29]

29 National Science Board, Science and Engineering Indicators 1998, 4-2.

As a national provider of R&D funds, the US government's portion of responsibility has been decreasing almost continuously over the past decade. Although partly explained by the corresponding increase in private sector R&D, such a decline is in no small measure attributed to the drop in defence spending. For the first time since 1981, the Department of Defence was, in 1998, expected to account for less than half of the federal R&D total. The only R&D performer that was not subject to cutbacks during the 1990s was academia.

Nonetheless, with some 736 federal laboratories commanding a budget of $21.6 billion in 1997, federal performance of R&D remains significant. Despite being distributed through 25 federal agencies, 80% of this sum is allocated to just three departments: the Department of Defence, the Department of Health and Human Services, and NASA.

The US federal government investment in R&D has not been founded in an economic strategy (Mowery & Rosenberg). The administration and financial structures which are fragmented in both the Executive branch and Congress (See Table 5-4), have made evaluations of the economic benefits derived from public R&D rare.[30] This complex organization has, however, allowed for a high degree of pluralism and diversity enhancing the ability of the Federal Government to "'buy' the best research available from many sources and to support R&D for many different reasons."[31]

## 7.3 *Government performers*

With nearly all the government agencies performing R&D, there is no single department responsible for science and technology. The bulk of federal R&D, however, is both funded and conducted through a relatively small number of agencies:

- Department of Defence (DOD)
- Department of Health and Human Services (DHHS)
- Department of Energy (DOE)
- National Aeronautics and Space Administration (NASA)
- National Science Foundation (NSF)
- Department of Agriculture (USDA)
- Department of Commerce (DOC)
- Department of Interior (DOI)
- Department of Transport (DOT)
- Environmental Protection Agency (EPA)

Generally, agencies whose R&D programs were established before World War II, perform a greater portion of their work in-house, whereas programs established at a later date are often carried out by extramural performers.

30 Mowery D, Rosenberg N, "The U.S National Innovation System", in *National Innovation Systems: A Comparative Analysis*, Ed. Nelson R. Oxford University Press, 1993. p.29.

31 Quoted from the 1995 *Industry Commission* report on research and development, Australian Government Publishing Services, H.1.

### 7.3.1 *Federally-funded laboratories*

As of 1995, the US General Accounting Office counted 515 laboratories, 65 of which had some 221 satellite facilities giving a total of 736. Geographically, each state was home to at least one laboratory, with California having the most at 46. Three laboratories run by the USDA and two by the Navy are located outside of the United States. Of the 736 labs, only 5 to 10 percent are of significant size and all are mission driven.

### 7.3.2 *FFRDCs*

Since most of the 38 Federally Funded Research and Development Centres are financed substantially, and in some case exclusively, by the federal government, they are classified here as part of government performed R&D (see Figure 7-1). Operating usually with budgets of more than $500,000, they are administered either through universities, non-profit organizations, or by private firms, and are staffed mostly with non-teaching scientists and not civil servants, as is the case with federal intramural laboratories. FFRDCs normally have a particular R&D objective or are mandated to provide research and training facilities in a specified field. FFRDCs include research laboratories, R&D laboratories, study and analysis centres, and systems engineering/systems integration centres, the majority of which are working in defence related areas.

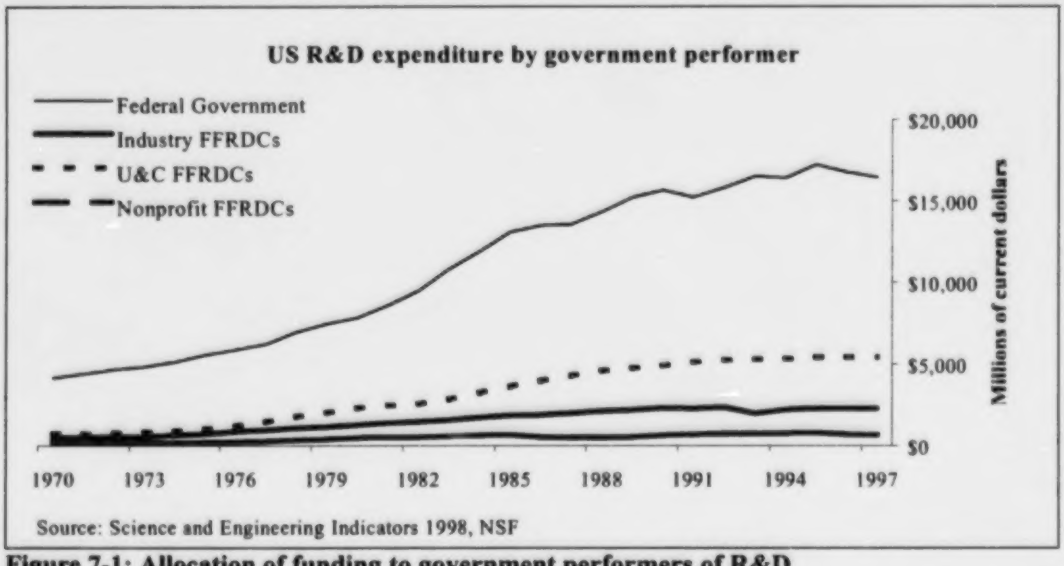



**Figure 7-1: Allocation of funding to government performers of R&D**

# 7.4 *Policy issues*

## 7.4.1 *Policy makers & priority setting*

Priority setting in the US is best characterised by its complexity and pluralism. As illustrated in Table 7-1 below, influences on priorities and policy come from all areas of the science system. Both the executive and legislative branch are sources of influential S&T reports and policy analysis, drawn up from an assortment of committees and councils, and the agencies themselves. Shaping priorities and policy from outside of government are non-government institutions and trade associations, some of which provide their own authoritative and influential reports and advice.

**Table 7-1 : Summary of US S&T policy makers**

| Branch | Source of influence |
|---|---|
| ***Executive*** | |
| Office of Science and Technology Policy (OSTP) | ▪ Provides high-level scientific advice to the President and closest staff |
| National Science and Technology Council (NSTC) | ▪ Cabinet-level group that co-ordinates federal R&D across government agencies with the aim of accomplishing multiple national goals. |
| President's Committee of Advisors on Science and Technology (PCAST) | ▪ Provides feedback about federal programs and actively advises the NSTC about science and technology issues of national importance from the community level |
| Office of Management and Budget (OMB) | ▪ Reviews federal R&D programs in context of all other programs;<br>▪ Perform special analysis of R&D and basic research cutting across agency boundaries to balance support to various disciplines |
| Agencies of the Executive Branch (e.g. DOD, NASA etc.) | ▪ Contribute a substantial amount of policy in respective areas;<br>▪ Each agency has own policy-making structure influenced internally and externally by advisory groups. |
| Critical Technologies Institute | ▪ Think-tank identifying essential technologies amongst other activities, and reporting to the OSTP |
| ***Legislative branch*** | |
| Congressional Committees | ▪ Authorization of expenditure;<br>▪ Legislative and oversight responsibilities for a wide range of federal R&D programmes (House of Representatives Committee on Science and Technology) |
| Congressional Research Service (CRS) | ▪ Publishes reports through their Science Policy Research Division |
| General Accounting Office | ▪ Has Science and Technology Group which carries out science policy related studies in response to Congressional demands |
| ***Non-government institutions in science and technology policy*** | |
| National Academy of Sciences (NAS) (also the American Association for the Advancement of Science (AAAS) etc.) | ▪ Authoritative advice and policy guidance to federal agencies;<br>▪ Produce influential status reports in disciplines of basic research |
| Trade Associations | ▪ Act as traditional interest groups in the US policy system |

*Sources*: World Technology Policies (1992), the OSTP & Skolnikoff (1995)

In a formal 1994 statement on science policy, *Science in the National Interest*, the Clinton Administration made clear its goal to ensure US leadership in scientific knowledge. In addition, the statement announced that the US would:

- Enhance connections between fundamental research and national goals.
- Stimulate partnerships that promote investments in fundamental science and engineering and effective use of physical, human and financial resources.
- Produce the finest scientists and engineers for the twenty-first century.
- Raise the scientific and technological literacy of all Americans.

Assisting in attaining these goals, are both the National Science and Technology Council (NSTC), a cabinet-level group, and the President' Committee on Science and Technology (PCAST), an advisory group representing the community level. The NSTC, established by executive order in 1993, co-ordinates the science and technology across the government to further international co-operation in science and technology and to establish clear national goals for Federal science and technology investments. In addition, the NSTC is required to make recommendations to the Director of the Office of Management and Budget on research and development budgets that reflect national goals.

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organisation and Priorities Act of 1976. OSTP's responsibilities include advising the President in policy formulation and budget development on all questions in which S&T are important elements; articulating the President's S&T policies and programs, and fostering strong partnerships among Federal, State and local governments, and the scientific communities in industry and academe.

**Critical technologies**

During the Bush administration, under pressure from Congress, agencies were asked to draw up lists of technologies deemed essential in attaining such ends as improved industrial competitiveness, increased economic growth and job creation, and better standards of living and national security. These so-called lists of 'critical technologies' appear, however, to have had little impact on government funding of R&D.[32]

### *7.4.2 Government Performance and Results Act*

1993 saw the beginning of the Government Performance and Results Act phases in new administrative requirements for agencies designed to:[33]

- Improve the confidence of the American people in the capability of the Federal Government, by systematically holding Federal agencies accountable for achieving program results;

- Initiate program performance reform with a series of pilot projects in setting program goals, measuring program performance against those goals, and reporting publicly on their progress;

- Improve Federal program effectiveness and public accountability by promoting a new focus on results, service quality, and customer satisfaction;

[32] Industry Commission, 1995
[33] GPRA, http://www.npr.gov/library/misc/s20.html

- Help Federal managers improve service delivery, by requiring that they plan for meeting program objectives and by providing them with information about program results and service quality
- Improve congressional decisionmaking by providing more objective information on achieving statutory objectives, and on the relative effectiveness and efficiency of Federal programs and spending; and
- Improve internal management of the Federal Government.

In adhering to this act, agencies, including all government laboratories, are required to prepare ***strategic plans*** which include a) a comprehensive mission statement, general goals and objectives, b) a description of how the goals and objectives are to be achieved, and c), a description of the program evaluations used in establishing or revising general goals and objectives.

Also, every year agencies are to prepare ***performance plans*** that will include a) establish performance goals to define the level of performance to be achieved by a program activity, b) express such goals in an objective, quantifiable, and measurable form, c) establish performance indicators to be used in assessing the relevant outputs, and d) provide a basis for comparing actual program results with the established performance goals. In the year 2000 performance reports will be required by congress on each program.

In an effort to improve ***managerial accountability and flexibility*** agencies will be permited this year to propose ways to avoid current administrative procedural requirements and controls, (e.g. specification of personnel staffing levels, limitations on compensation or remuneration, and prohibitions or restrictions on funding transfers) in return for specific individual or organization accountability to achieve a performance goal.

### *7.4.3 Financing*

Federal 'intramural' R&D, as a percentage of total national R&D performance, has been in decline since the early 1970's, reaching its lowest point since 1982 at an estimated 8% in 1997(NSB 1998). Much of this decline has come about from significant budget cuts to the department of defence, which in 1997 accounted for 48 percent of the total federal R&D, down from 56 percent in 1982.

This figure however cannot be compared directly to other countries' government R&D since it excludes what are called Federally funded research and development centres (FFRDC)[34] and non-profit FFRDC which together accounted for 4 percent and 3 percent respectively in 1997 (NSB 1998).

34 A few FFRDCs are in fact often referred to as national laboratories such as Sandia, and Los Alamos the latter of which is administered through the University of California. With 60 percent of the FFRDCs total expenditure coming from the DOD, much of the work remains defense oriented.

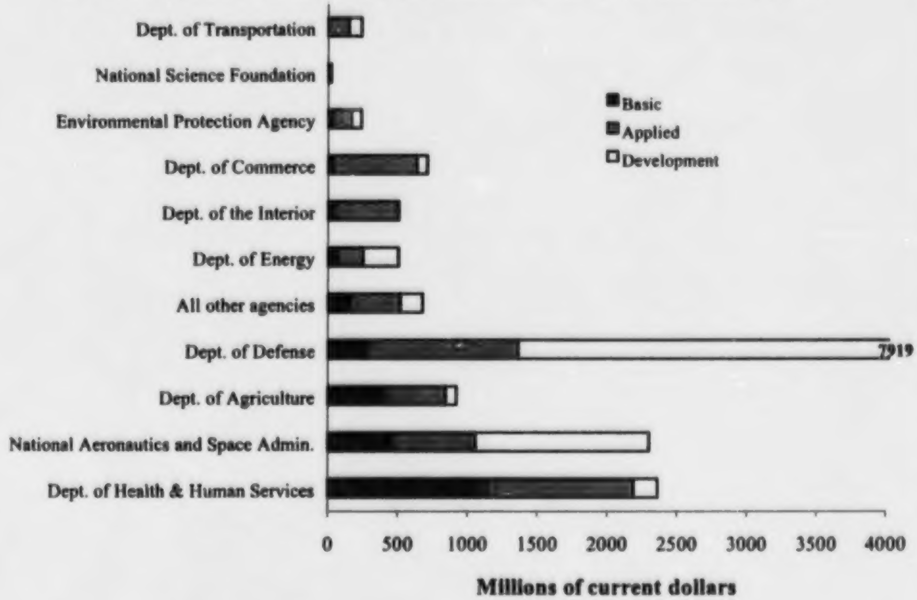
Beginning in the late 1980s, the US R&D budget experienced significant reductions in large-scale defence, space and energy programs. However, given the rise in the 1998 budget from the previous year, the decline that was projected to continue on through the year 2002, could, according the National Science Board, prove to be at an end. The National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), and applied research at the Department of Defence (DOD) each received an increase in 1998 with a further rise expected in 1999 in Health and Human Services, the NSF and the Department of Energy (DOE). Cuts in funding from 1997 levels were made to the National Aeronautics and Space Administration (NASA), DOE and basic research in DOD. Figure 7-2 shows the allocation of funds by both character of work and department.

## Character of Research

With the level of funding for federal basic research relatively unchanged over the past decade (Figure 7-3), the overall decline in federal research has primarily affected applied research and development. By NSB figures, federal performance in development has been declining at an average annual rate 3.7% over the last decade.

Despite the cuts, support for basic research in federal government institutions has remained relatively constant in the last decade.

US R&D expenditure by department as performed by federal government - FY 1997




Source: Science and Engineering Indicators 1998, NSF

**Figure 7-2: Allocation of government funds by character of work and agency**

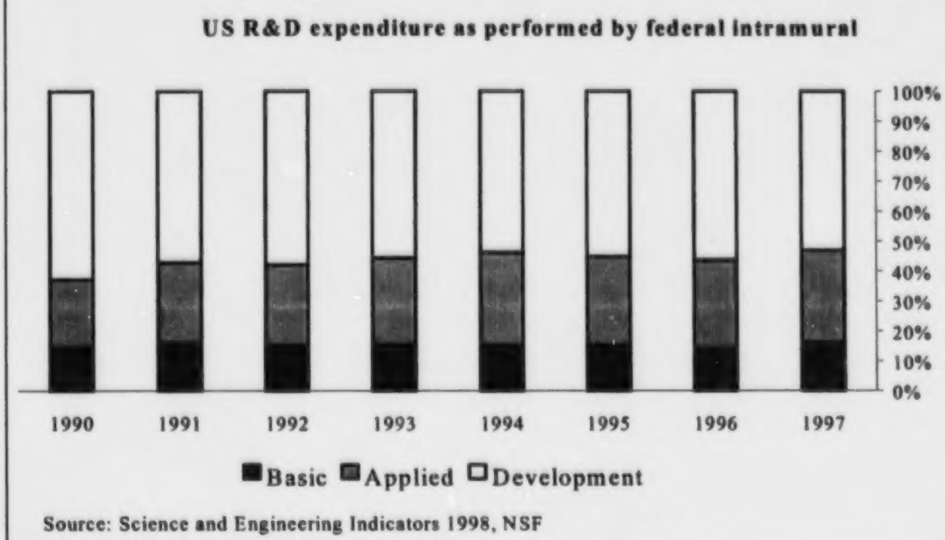



**Figure 7-3: US intramural research**

## *7.5 Recent S&T Reviews*

### *7.5.1 Unlocking a New National Science Policy: Toward A New National Science Policy*

(House Committee on Science, September 24, 1998)

Of the 40 recommendations made, eight are specifically relevant to government S&T. These eight, listed below, have been quoted verbatim from the report:

- To maintain our Nation's economic strength and international competitiveness, Congress should make stable and substantial federal funding for fundamental scientific research a high priority.
- Because the federal government has an irreplaceable role in funding basic research, priority for federal funding should be placed on fundamental research.
- In general, research and development in federal agencies, departments and the national laboratories should be highly relevant to and tightly focused on agency or department mission.
- National laboratories not involved in defence missions should be selected to participate in a corporatisation demonstration program in which a private contractor takes over day-to-day operations of the lab.

- Government agencies or laboratories pursuing mission-oriented research should employ the Results act[35] as a tool for setting priority and getting the most out of their research programs. Moreover, in implementing the Results Act, grant-awarding agencies should define success in the aggregate, perhaps by using a research portfolio concept.

- In general U.S participation in international science projects should be in the national interest. The U.S. should enter into international projects when it reduces the cost of science projects we would likely pursue unilaterally or would not pursue otherwise.

- Decision-makers must recognise that uncertainty is a fundamental aspect of the scientific process. Regulatory decisions made in the context of rapidly changing areas of inquiry should be re-evaluated at appropriate times.

- Government agencies have a responsibility to make the results of federally funded research widely available. Plain English summaries of research describing its results and implications should be prepared and widely distributed, including posting on the Internet.

### *7.5.2 Federal Laboratory Review*

From a request in 1994 by President Clinton, the NSTC carried out a review of the Federal laboratories operated by the DOD, DOE and NASA, the three largest laboratory systems, to evaluate and develop recommendations for ways to improve their efficiency and effectiveness. This review resulted in the creation of general guidelines and principles that were subsequently endorsed by a Presidential Decision Directive in 1995[36], recommending that agencies:

- Review and as appropriate rescind, internal management instructions, regulations and redundant oversight that impede laboratory performance.

- Clarify and focus mission assignments for their laboratories, eliminating redundancy and restructuring the laboratory systems as appropriate and necessary.

- Achieve all possible savings through streamlining and improving management and as necessary reduce or eliminate low priority programs based on priorities set by the NSTC and the National Security Council.

- Continue to search for opportunities to co-ordinate and integrate laboratory resources and facilities on an interagency and inter-service basis.

[35] The Government Performance and Results Act (GPRA) was designed to improve accountability, productivity, and effectiveness of Federal programs through strategic planning, goal setting, and performance assessment.

[36] Statement by the President, Future of Major Federal Laboratories, The White House, Office of the Press Secretary, September 25, 1995.

### 7.5.3 *Assessing Fundamental Science*

Following the 1993 Government Performance and Results Act (GPRA), which called for improved accountability, productivity, and effectiveness of Federal programs, the NSTC began a review of fundamental science. The report *Assessing Fundamental Science* released in 1995 reviews public and private experience with the assessment of fundamental science, offers basic assessment principles, and provides information about performance measures. *Assessing Fundamental Science* provides Federal agencies and departments with a consistent set of general principles and high-level goals for the assessment process in fundamental science.

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House Committee on Science, *Unlocking Our Future: Toward a New National Science Policy*, 1998, US

## *8.3 Interviews*

**Table 8-1: Interviews**

| Country | |
|---|---|
| **Australia** | Prof. S. Serjeantson (FASTS) |
| | Dr K. Baldwin (FASTS) |
| **Canada** | Prof. David Wolfe (U of T) |
| **Finland** | Professor J. Tuomisto (KTL) |
| | A. Kuparinen (DG Tech. Policy Div.) |
| **Netherlands** | L. Soete (MERIT) |
| | Mr. Van Heeringen (AWT) |
| **UK** | S. Elton (OST & Secretary of Council) |
| | D Cope (POST) |

*Note:* Over 25 formal requests have been made requesting participation in this study.

## Appendix I - Departmental Profiles

This appendix to the report *Science in Government Decision-Making: The Canadian Experience* is a set of departmental profiles that are intended to provide more focussed insights on the science based departments and agencies that were targeted in the study. Each profile touches on the departmental mandate, the key features of its use of science for government decision-making, and some of the existing policies and procedures in place or under consideration. They also highlight current issues (as seen by various interviewees) concerning the use of science in decision-making.

These are necessarily very condensed and contain some subjective assessments by the project team in terms of the policies and procedures relevant to this study and the current issues. Time constraints also precluded an extensive review of any one of the target departments. The authors take full responsibility for the views expressed.

Profiles:

## Agriculture and Agri-Food Canada

### *1. Context for Use of Scientific Advice*

The mandate of the Minister of Agriculture and Agri-Food is to promote the development, adaptation and competitiveness of the agriculture and agri-food sector. The Minister has the ultimate responsibility for strategic policy and planning for the Agriculture and Agri-Food Portfolio which includes, inter alia Agriculture and Agri-Food Canada (AAFC) and the Canadian Food Inspection Agency (CFIA).

The mission of Agriculture and Agri-Food Canada (AAFC) is primarily economic, "to work with industry and other partners to:

- improve and secure market access and enable the agriculture and agri-food sector to capture opportunities for trade in domestic and export markets, with a focus on higher value-added agri-food products;
- support the sector's efforts to develop and produce competitive products and processes in an environmentally sustainable manner;
- enhance the sector's economic viability while strengthening opportunities for rural economic development."

Reporting to the Deputy Minister of AAFC are the Assistant Deputy Ministers (ADMs) responsible for Policy Branch, Research Branch, Market and Industry Services Branch, and Corporate Services Branch and the Directors General responsible for Review Branch, Communications Branch, Prairie Farm Rehabilitation Administration (PFRA) and Human Resources Branch.

There are four business lines, that entail branches working together to deliver on departmental priorities:

- Expanding markets;
- Innovating for a sustainable future;
- Strong foundation for the sector and rural communities;
- Sound department management.

All activities of Research Branch are aligned under the second business line which is shared with PFRA and the Policy Branch's Environment Bureau. The immediate client for most of the outputs of its science capacity is the agricultural and agri-food industry in supporting the sector efforts to develop and produce competitive products and processes in an environmentally sustainable manner. Government decisions on the environmental, land and water policies, and transportation and trade policies will involve departmental input, normally in cooperation with other departments and agencies. While some component of AAFC's activities continue to be related to safety and health (disease control and food safety), the creation of a separate Canadian Food Inspection Agency (CFIA) and Pest Management Regulatory Agency (PMRA) have modified the balance of activities within the department. Note: CFIA, while separate from AAFC, is still under the Agriculture and Agri-Food Portfolio and under the

responsibility of the Minister of Agriculture and Agri-Food; PMRA is under the responsibility of the Minister of Health.

A Memorandum of Understanding (MOU) between the AAFC and CFIA includes an appendix concerning research that provides a framework for cooperative activities by:

- confirming the business of both parties;
- defining the nature and responsibilities of each organization;
- identifying priorities and the areas of common interest;
- establishing joint planning activities.

The Research Branch has five "Key Result Area Expected Outcomes":

- Resources - services and technologies which conserve soil, water and air quality, as well as genetic resources;
- Crops - new stress resistant crop varieties and crop production and protection systems;
- Animals - new animal production and protection systems;
- Food - new value-added food and non-food products and processes;
- Collaboration - increased level of collaborative research between industry and the department.

## 2. *Practices and Procedures*

External advisory structures:

- Canadian Agri-Food Research Council (CARC) structure (including its Expert Committee system) seen as being a prime source of external science advice. It includes members from federal and provincial governments, industry, academe, scientific societies, producers' groups, civil society organizations (industry personnel represent more than half the membership).
- Research Branch Advisory Committee (RBAC) comprising people from the food processing and producer industries that meets twice a year, provides networked advice from well connected people, a sounding board for priorities developed by the Research Branch and an environmental scan. The Committee is oriented to industry; no environmentalists or consumers at present.
- Each of approximately 18 research centres has access to a research advisory committee comprising producers, industry and university representatives. The four centres in Atlantic Canada are served by one advisory committee.

Sources of scientific advice to AAFC:

- In-house expertise contributes a significant component of the science input to decision making. Research Branch does not commission R&D, but does cooperative work with industry and university researchers.
- Additionally, AAFC participates in and uses multi-partite advice on technical issues developed

through the 27 expert and Canada committees of the Canadian Agri-Food Research Council. These examine issues related to natural resources, crops, animals, and food. The 7 provincial agricultural coordinating committees also input information and recommendations to CARC.

- Joint action with other stakeholders in the "issue round tables" (e.g., Kyoto convention - greenhouse gases).

External Review:

- Every 5 years a research centre gets a full scientific review. The bulk of the members are external, the focus is strategic. These reviews are managed by AAFC.
- There is no recent written policy framework for the reviews. Operationally, a Centre DG prepares Terms of Reference and appoints a Chair; together they select the members of an external review committee. Such review may include international experts. A staff person outside the unit under review may act as secretary.

Quality assurance:

- Quality for partnered work validated through client willingness to cost share; work with industry/client/producer/stakeholder.
- Peer reviewed publications as indicators of quality for long-term work that is funded from core budget.
- Client orientation needed for relevance, including research partnerships through matching investment incentives.

Horizontal Issues:

- Participation in 5 NR MOU on sustainable development is very important. Initial focus - discussions on common issues, including rationalization and priorities. This evolved to a forum for more specific cross cutting issues, e.g., coastal zone management, nutrients in water, heavy metals in water, and has led to collaborative research initiatives particularly development/synthesis of scientific information for policy (e.g., Kyoto).

Science-policy interface:

- Policy Branch deals with larger policy issues, including sustainable development, climate change, biodiversity and income support. The Policy Branch relies extensively on the Research Branch for scientific advice.
- A policy unit within the Research Planning and Coordination Directorate of Research Branch is responsible for the management of horizontal issues in S&T, (e.g., intellectual property issues, ethics and best practices, coordination of the activities under the 5NR MOU).
- Designated issue and sector coordinators in the Research Branch have a mandate to bridge the science to policy interface.
- Policy Branch deliberately makes the effort to bring in people to the policy shop who can deal with science; this is relatively difficult and rare, but essential for policy development and

decision making in areas that are highly technical such as greenhouse gases emissions, biodiversity and biotechnology.

- Examples of how the planning process translates policy into S&T activities that in turn supports further policy:
  - international trade → targets → policy changes needed → impacts on sustainable development → S&T agenda.

### 3. *Current Issues*

Anticipatory capacity:

- Some big gaps - e.g., identity preservation system for wheat; many biotechnology policy issues, including consumer acceptance.
- The importance of greenhouse gases in the agricultural sector was not foreseen in time to build internal capacity to respond effectively to the Kyoto Agreement on emission levels.

Capacity issues:

- Capacity to deal with various dimensions of biotechnology, including protection of IP, genetic material from developing countries; the dominance of one industrial player.
- Nutraceuticals - Question of capacity to understand the policy implications and bargain internationally in good faith on functional foods and genetically modified food stuffs, even before the question of what is government policy is addressed.
- Ethical dimensions of food production.

Horizontal issues:

- Biotechnology file - difficulty in championing a cross-cutting issue (7 departments for each of which it is important, but not the #1 priority). Has a strong 'public good' component. Such initiatives can too easily fall through the cracks.

Industry orientation:

- Industrial orientation of department and the matrix of advisory boards excludes, in large measure, participation of the ultimate consumer and environmental groups. There is a question of whether the "science for policy" component of the AAFC mission is adequately represented in the current structure as it pertains to identification of emerging issues or development of the science capacity to underpin policy decision making. This also becomes a question of openness.
- Provincial governments, as users of the science outputs, have noted a decrease in AAFC contributions to their "science anticipatory capacities" and attribute this to funding AAFC research through the Matching Investment Initiative. The previous practice of interim reports on research activities served a very effective foresight role. While final reports are still available under the new approach, they do not have the same lead time.

- Question of whether the committees of CARC are too close to the department to give broadly based independent advice.

Identified barriers to science in decision making:

- Significant issues continue in setting priorities in research that respond to policy needs, while retaining long term flexibility.
- Need to better bridge science and policy; need training, cross assignments, more interchange among departments.
- Lack of capacity within PCO for dealing with science issues; need for more understanding of nature and role of science advice.
- Concept of return on investment seems not to extend to public interest.
- Difficulties in communicating uncertainties in policy.
- Science advice not available in a timely fashion.

### *4. Documentation*

- *Agriculture and Agri-Food Canada 1996-97 Estimates: A Report on Plans and Priorities. Pilot Document.* Review of Departmental programs, priorities and performance framework.

- *Agriculture and Agri-Food Canada Performance Report For the Period Ending March 31, 1998.* Report of progress against goals established in the 1996-97 year.

- *Research Branch Business Plan 1995-2000.* Includes an overview of the structure of the Branch, the advisory committees and the process for priority setting. http://www.agr.ca/research/resplan/businee.html#department.

- *Innovating for a Sustainable Future: Plans for 1999-2002.* Plan and responsibility centres for activities of AAFC in relation to three "key results areas":
    - innovation
    - sustainable resource use
    - integrated policies and decision making

  Outcomes, rather than process oriented. Outlines indicators.

- *Canada's National Strategy for Agri-food Research and Technology Transfer 1997-2002.* Canadian Agri-Food Research Council of Canada 1997. Five-year strategy developed following consultation with members of the agri-food community in the federal, provincial, university and private sectors. Focus - competitiveness and viability.

- *Memorandum of Understanding between Agriculture and Agri-Food Canada and the Canadian Food Inspection Agency - Appendix Concerning Research.* Outlines the

relationship between AAFC and CFIA, including the relative responsibilities of both parties and the process to identify areas of mutual interest and the support of AAFC Research for the CFIA mandate.

- *Make it Happen with the Matching Investment Initiative.* Brochure on the AAFC program to boost R&D investment in areas of mutual interest with partners.

### *Appendix - Agriculture and Agri-Food Canada Advisory Committee Structure*

National agricultural research needs are identified and priorities established through consultation with several key sources. Guided by the Minister's priorities, organizations that have input into this process include:

1. Research Branch Advisory Committee (RBAC);
2. Research centre advisory committees;
3. Canadian Agri-Food Research Council.

#### *1. Research Branch Advisory Committee (RBAC)*

*Background*

The purpose of the Research Branch Advisory Committee (RBAC) is to provide advice and counsel on research and development priorities and programs to the Research Branch, Agriculture and Agri-Food Canada.

The RBAC will provide a focus for food and agricultural research priority setting to support the competitiveness of the agri-food sector by: identifying broad research needs; reviewing research activities and recommending a balanced response to both regional and national needs.

*Functions*

More specifically, the role of the RBAC will be to:

1. Make recommendations with respect to the development of food and agricultural research programs and priorities.
2. Advise on ways to foster more effective technology development, application and transfer to client groups.
3. Advise on ways to increase private sector investment in agri-food R&D.

4. Evaluate the business plan of the Research Branch advising on operational issues.
5. Advise on strategic research directions and ways to avoid competition with existing private sector, university and provincial government activities in research and technology development.
6. Foster communication between public sector researchers and industry.

*Composition*

The RBAC will be comprised of senior private sector appointees representing agribusiness, processors, producers and consumers. Private sector membership will be limited to a maximum of ten (10).

A private sector appointee will serve as Chairperson of the Committee. The Assistant Deputy Minister, Research Branch, will serve as Co-Chairperson. The selection criteria for the position of Chairperson will be seniority based. The Chairperson will be identified by consensus of the members.

Appointments to RBAC will be made based on nominations made by, and subsequent approval of, both the Chairperson and Co-Chairperson.

Appointments should reflect the business lines within the Research Branch. Specifically, there should be representation from the resource, animal, crop, and food sectors. Insofar as is possible, every effort should be made to address geographic balance, linguistic and gender considerations.

The duration of appointments will be three years, to ensure continuity. Appointments may be extended for one or two additional years to a maximum five year term of appointment.

Two senior Agriculture and Agri-Food Canada officials may be appointed as federal government representatives on RBAC. The Chairman of the Canadian Agri-Food Research Council (CARC) will be an ex-officio member of the Committee.

*Operations*

The RBAC will meet at least annually at the call of the Chair.

Secretariat support to the RBAC will be provided by the Research Branch.

The RBAC shall be empowered to establish sub-committees and make reasonable work assignments to its members. Any sub-committees could be chaired by private sector members.

*Compensation*

Members will be compensated by the Research Branch for travel expenses in accordance with Treasury Board guidelines. No other compensation will be paid.

### 2. *Research centre advisory committees*

Each research centre has an advisory committee to provide advice and counsel on research priorities and programs. These advisory committees focus on research and technology issues that pertain to the national or regional mandate of the centre they serve.

### 3. *Canadian Agri-Food Research Council (CARC)*

The Canadian Agri-Food Research Council (CARC) helps to focus the research efforts by all performers of R & D nationwide to avoid duplication, ensuring that research performers get the most out of their investment.

Objectives:

- to identify emerging research and related educational issues, and recommend suitable action;
- to coordinate and to be a catalyst for research priority setting in Canada;
- to be a catalyst for strategic planning on commodities, products, and special issues;
- to build networks among industry, governments, and universities for mutual benefit;
- to communicate CARC's activities to all participants;
- to advise all participants concerning current agricultural research issues;
- to review and renew regularly the National Strategy for Agri-Food Research and Technology Transfer.

CARC has 32 members, representing the federal and provincial governments, industry, scientific societies civil society, organizations and the universities. Reporting to CARC are:

- 5 standing and ad hoc committees;
- 7 provincial agricultural coordinating committees, with the Atlantic provinces operating as a unit;
- 4 Canada committees and their 27 expert committees investigating issues related to natural resources, crops, animals, and food.

## Canadian Food Inspection Agency

### *1. Context for Use of Scientific Advice*

CFIA, which came into being on April 1, 1997, has a mandate to enhance the effectiveness and efficiency of federal inspection and related services for food and animal and plant health. Reporting through the Minister of Agriculture and Agri-Food Canada, its creation brought together inspection services previously distributed across four departments - Health Canada, Agriculture Canada, DFO and Industry Canada.

The driving force behind the creation of CFIA was the recognition that Canada's food inspection system operated in a changing domestic and international context. International trade agreements, the application of biotechnology to the food industry, changing demographics and dietary needs, as well as the ethnic makeup of Canada required a more proactive and flexible approach in system design and delivery than was likely under the former complex division of responsibilities between various departments and levels of government. The new organizational structure is described as facilitating a more uniform and consistent approach to safety and quality standards, and risk-based inspection systems, contributing to consumer protection, facilitating market access, improving service delivery and a greater degree of coordination among federal departments and with other levels of government.

The role of CFIA as a key regulatory arm of government in the overall food system (extending to animal, plant and fish) was characterized in the original Blueprint in the context of the responsibilities of all partners:

1. ***Industry*** has primary responsibility for the safety and quality of product, and to provide a reasonable level of descriptive product information to permit consumers to make informed decisions.

2. ***Consumers*** have a right to be informed and the responsibility to handle food properly.

3. ***Government*** has a responsibility:
    - to set and enforce standards pertaining to health and safety, based on sound scientific risk assessment and management principles;
    - to ensure that product information provided by industry is sufficient and accurate;
    - to provide health and safety information to consumers; and
    - to interact internationally to represent the interests of Canadian consumers and producers.

Interpreting these functions led to a redefined role for government in food inspection activities and the development of options for the delivery of non-health and safety related programs, through the use of

public good and private good criteria:

> *Generally, governments will focus their resources towards the continued assurance of the health and safety of the food supply, as well as economic fraud prevention. Services which are clearly defined as having only private benefit will be discontinued or provided on a cost recovery basis.*
>
> The Blueprint

The actual allocation of responsibilities for standards and compliance in regard to the various elements of the food system (gate to plate) is summarized in the table below.

| | *Sets Standards* | *Ensures Compliance* |
|---|---|---|
| Food safety and human health | Health Canada | CFIA |
| Animal and plant health | CFIA | CFIA |
| Fish health | DFO | CFIA |

At present there is a major process of legislative reform underway including modernization of statutes to reflect the food continuum (gate to plate) and national harmonization of standards. Among the intents is to improve CFIA's ability to address new and emerging scientific and technological advances and development (e.g. biotechnology).

In addition to maintaining an effective inspection service, CFIA provides support for the Minister in his responsibilities for establishing animal and plant health standards and underpins Canadian participation in international organizations for the purposes of maintaining and expanding international market access and protecting Canadian interests in relation to the food system.

These collective activities draw on the science competence of CFIA. CFIA views its clients as including all Canadian stakeholders in the food continuum.

### 2. *Practices and Procedures*

Source of science in advice:

- CFIA takes considerable care not to be seen to be allied with a large industrial firm to ensure credibility of its operations (in contrast with AAFC which considers the agri-food industry as prime client). Data considered in science and risk assessments may come from the firm, but joint projects would bring the perception of conflict of interest.
- Given the nature of the science and the time demands, science input is in-house; not the type of science that is done in universities.

Risk Assessment and Management:

- CFIA is a central player in risk assessment/management. Risk assessment is a shared responsibility with Health Canada (HC - risks to human health and safety; CFIA - risks to animal and plant health). Risk management is the cooperative responsibility of CFIA and partners (industry and government). There is an Animal Plant and Food Risk Assessment Network (APFRAN) within CFIA that harmonizes risk assessment methodologies across disciplines, serves as a liaison between science and management, and communicates with other agencies.
- Consistent with models evolving in other countries, CFIA has committed to inspection systems based on the principles of scientific risk assessment and to the allocation of resources to activities that result in effective risk management.
- New inspection methodologies entail charting the food continuum from production to consumption, identifying hazards along the continuum, examining the effectiveness and efficiency of control strategies in place and designing new strategies.
- At the heart of this approach are the principles of Hazard Analysis Critical Control Point (reproduced in the appendix to this profile). It is applied as a type of science-based benchmarking of critical points in the overall food production process at which problems can occur and used to trigger a product rejection/acceptance decision. In Canada compliance is voluntary; in the US, mandatory. CFIA registers companies (not a certification process, but a registration process) under HACCP. Appears effective.
- CFIA is also examining new approaches to risk assessment/management, including solicitation process (Harvard University) in which a sophisticated process of obtaining broad input on an issue is carried out by trained and skilled people. This is an FDA funded initiative in the US.

International:

- CFIA has a responsibility to identify and respond to food safety concerns from around the globe. Similarly, the inspection and quarantine services can affect the competitive position of products on world markets.
- As the "competent authority" for Codex Committees[1] in Canada (and in other like fora), CFIA participates in discussions on such issues as appropriate levels of protection and equivalency under global trade agreements. Such participation is expert-based.

Transparency:

- CFIA has an extensive web site that documents the various functions and structure of the

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[1]The Codex Alimentarius Commission is a subsidiary body of the UN World Health Organization and the Food and Agriculture Organization. It deals with a wide range of food issues related to safety, composition, additives, contaminants, nutrition, pesticide residues, and labelling. Following the most recent GATT discussions, Codex standards carry more weight and are becoming increasingly more important to national governments.

agency, the various Federal acts under which it is charged with administration, enforcement and compliance, the operational approaches used (e.g., plant pest risk assessment), decision documents and other related information designed to enhance public understanding of generic and regulatory issues of food safety.
- Strong tradition of publication in refereed journals within CFIA.

Quality assurance:
- Strong reliance on publications of individual scientists.
- Initiating a focussed discussion with clients (often with very sophisticated industrial labs) to explore issues of quality, especially the extent to which units are fully up-to-date.

Science - Policy Interface:
- In science advice/risk assessments, dissenting opinions are exposed to the Minister.
- Scientists will present to and respond to questions from Minister where issues likely to be controversial.

### *3. Current Issues*

Capacity:
- Agency concerned that even with new models of delivery, it may not have the science capacity to underpin its regulatory mandate in regard to new products, especially biotechnology.
- Science and science capacity for regulation is different than academic science.

Structure:
- Debate on CFIA structure among public policy analysts external to government. Some characterize CFIA as a model case history of structural reform with a carefully structured accountability regime for an integrated portfolio in which Ministerial accountability is retained, but significant regulatory responsibility is delegated. Others challenge it as not going far enough. At the same time, CFIA is generally regarded as having many "best practice" attributes, including:
  - new paradigm of industry managed system of inspection based on science and risk analysis;
  - integration of the larger food inspection system in a single organization;
  - cooperative action of federal and provincial governments on harmonization;
  - strong core of scientific expertise that is well linked with experts in Canada and internationally.

Precautionary Principle - interpretation across government:
- Need for more precision as to what it means.
- Need a cost/benefit element in decision-making framework.

- Need more intellectual rigour in how risk is approached (assessment and management).

Code of practice:

- Need to develop a clear code on what scientists can and should say in public to ensure balance of openness and respect for Cabinet solidarity.

## *4. Documentation*

- *A Blueprint for the Food Inspection System:* A Statement by the Joint Steering Committee of CFIS, the Federal/Provincial Agri-Food Inspection Committee and the Federal/Provincial/Territorial Food Safety Committee. 1995.

- *CFIA Corporate Business Plan 1997-2000.* Outlines the legal and program basis for CFIA, the operating environment and the business priorities and strategies.

- *CFIA Annual Report 1997-98.* Provides an overview of the first year of operation of the new agency.

- *CFIA A Plan for Legislative Renewal: Summary Report*. October 1998. Sets out a legislative plan for modernization and consolidation of the CFIA legislation following consultation with stakeholders.

- *CFIA Regulatory Process Overview.* Process for adopting and adapting regulations. September 28, 1998. Extract from Standard Operating Procedures.

- *Report of the Twenty-First Session of the Joint FAO/WHO Codex Alimentarius Commission. Rome 3-8 June 1995.* Includes a section on consideration of proposals to base Codex standards and other recommendations on scientific principles and the extent to which other factors need to be taken into account.

- *Alternative Service Delivery and the Public Interest: The Case of the Canadian Food Inspection Agency (CFIA).* Ronald L. Doering, CFIA. Presentation to the International Congress of Administrative Science. Paris, France. May 30, 1998.

- *Reforming Canada's Food Inspection System: The Case of the Canadian Food Inspection Agency (CFIA).* Ronald L. Doering. September 1998. Journal of the Association of Food and Drug Officials, Volume 62, No. 3.

## Appendix - Canadian Food Inspection Agency

### Hazard Analysis and Critical Control Point (HACCP)
### Seven CFIA Principles for the Development of an HACCP Plan

The Hazard Analysis Critical Control Point approach for health and safety risks has gained international acceptance and is a priority thrust for CFIA. Over the next few years CFIA will move towards a staged requirement for HACCP in federally registered food-processing facilities. The seven principles of HACCP are:

- Identification of hazards and development of preventive measures;
- Determination of critical control points (CCPs) required to control the identified hazards;
- Establishment of limits that must be met at each CCP;
- Appropriate monitoring procedures for CCPs;
- Establishment of deviation procedures at CCPs;
- Procedures for verification that an HACCP plan is working;
- Documentation of all procedures and records appropriate to the above principles.

### Codex Alimentarius Commission[2]
### Food and Agriculture Organization of the UN

Statements of Principle Concerning the Role of Science in the Codex Decision-Making Process and the Extent to Which Other Factors are Taken into Account

1. The food standards, guidelines and other recommendations of Codex Alimentarius shall be based on the principles of sound scientific analysis and evidence, involving a thorough review of all relevant information, in order that the standards assure the quality and safety of the food supply.

2. When elaborating and deciding upon food standards Codex Alimentarius will have regard, where appropriate, to other legitimate factors relevant for the health protection of consumers and for the promotion of fair practices in food trade.

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[2]Codex Alimentarius Commission (established 1962 under the FAO/WHO):

- sets international food standards; concerned with public health and safety, food born disease ...
- operates through 30 volunteer committees, including significant scientific base - set international standards; mode of functioning - through consensus.
- Canada chairs Codex Committee on food labelling. CFIA the "competent authority" for Codex committees in Canada.

3. In this regard it is noted that food labelling plays an important role in furthering both of these objectives.

4. When the situation arises that members of Codex agree on the necessary level of protection of public health but hold differing views about other considerations, members may abstain from acceptance of the relevant standard without necessarily preventing the decision by Codex.

Note - in June 1995 the Joint FAO/WHO Commission asked the Secretariat to draw to the attention of the Directors-General of FAO and WHO the Commission's desire to increase transparency in the working procedures of expert panels, including procedures for the selection of experts, declaration of interest, and assurance of adequate geographical representation of experts.

## Environment Canada

### *1. Context for Use of Scientific Advice*

The departmental mission is to "make sustainable development a reality in Canada". Environment Canada undertakes and promotes programs to support four mutually reinforcing business lines:

- clean environment;
- weather and environmental predictions;
- nature and management administration;
- policy.

There is a strong international dimension to the mission of the department and extensive linkages with the activities of other departments and agencies.

Environment Canada is a strongly science based department with approximately 90% of its expenditures devoted to S&T, within which some 20-25% is R&D and the residual "related scientific activities" RSA (a very high level of RSA in comparison, for example, with NRCan). Of the overall S&T activity, officials estimate that approximately 50% is dedicated to delivery of mandated activities under a number of federal acts, chief among them being the Canadian Environmental Protection Act (CEPA) and the Migratory Birds Convention Act. In total 14 acts are administered in whole by Environment Canada and an additional 18 are administered in part by Environment Canada (7) or administered by others with the support of Environment Canada (11). The residual 50% of S&T activities support policy development, international negotiations and surveillance, and a range of other related activities.

The range of S&T activities includes:

- providing the scientific underpinning for environmental policies;
- determining methods of measuring pollutant concentrations, transport and processes;
- developing environmental policies, regulations and technologies that aim to prevent pollution;
- conducting studies of biodiversity, wildlife preservation, and conservation of endangered species;
- monitoring the state of the environment;
- developing and maintaining environmental data bases;
- responding to environmental disasters;
- collecting information to ensure compliance with regulations;
- developing global and regional climate models and predictions of the state of the atmosphere;
- operating the Canadian weather and climate monitoring networks and providing weather and air quality forecasts;
- conducting assessments of the state of science regarding particular environmental issues;
- technology transfer.

Departmental officials characterized the science-to-policy process in Environment Canada as very different from that of a regulatory agency that was mandated to respond to external developments. Within Environment Canada, the science is said to drive the policy, or determine what is done (e.g., insights on endocrine disrupters). Additionally, there is an extensive federal-provincial interface. The provinces are the prime source of regulation, while the federal government provides the overarching framework--a science based assessment of what will make the most difference, using the power of knowledge as a means for influence. Federal-provincial committees are a normal part of business and a key linkage between science and policy. The Canadian Forest Service functions in a similar manner.

Within Environment Canada, some decisions reside at Ministerial level, some are delegated. For example, decisions on harvest levels for endangered species are delegated to the DG level; effluents from pulp mills go to the Governing Council, renewal/revision of the CEPA legislation would go to Cabinet.

## 2. *Practices and Procedures*

Science Assessment:

- Major thrust in developing a strong science assessment process. Formal science assessment process has been developed that involves :
    - Separate group of science advisors who work with policy makers to design the policy questions that need to be answered for policy development;
    - Review of these questions by policy and science managers and the science community before assessment process is set up;
    - Preparation of science assessment document;
    - Peer review of science assessment document;
    - Advice to policy makers developed and provided.
- The process can involve stakeholders and a range of Canadian (in-house and external) and international scientists. There is a procedure for dealing with dissenting opinions. Overall the process is recognized as important, but time consuming.
- Environment Canada is attempting to become more systematic about what should be in science assessments (including indicators) through the 5 NRs[3] group. Also, a draft document has been produced that integrates the requirements for State of the Environment reporting with science assessments prepared for specific decision-making needs.
- Several different types of inputs to science synthesis activity: EC assessments; Federal government assessments (inter-departmental); Canadian assessments; international

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[3]5 NRs - Group of 5 Natural Resource Departments that have signed a Memorandum of Understanding on sustainable development - Natural Resources Canada, Environment Canada, Agriculture Canada, Fisheries and Oceans Canada and Health Canada.

assessments; integrated assessment modeling; science forums.

S&T management framework in place (one of two such frameworks in place in federal SBDAs; see Appendix to this profile for more information) that, inter alia:

- links research activities with departmental priorities;
- promotes excellence in S&T.

Quality assurance:

- Currently under consideration is a draft framework for a formal system of regular expert review of the departmental R&D. If adopted, this would pertain to:
    - programs involving large numbers of researchers (>10) or resources (> $1M);
    - research branch or cross branch activities;
    - international studies where significant contributions are expected from the department.
- Major elements include:
    - Review of proposals by external stakeholders (ex ante);
    - Scientific peer review of R&D programs and results (concurrent) every 3-5 years (e.g., publications in peer reviewed journals);
    - External impact assessment on completed programs (ex post) - documenting environmental, social and economic impacts of the research.

Anticipatory capacity:

- Vital for nature of mandate. For example, the department determines what goes into the Toxic Substances List - there is a cost of making major errors on inclusion or exclusion;
- Gap - biotechnology. An adequate knowledge base takes time to develop, it is cumulative. Significant deficit.

Preparation of MC's:

- Major scientific role likely to be played by technical person at a director level. Bench scientists unlikely to be directly involved;
- Environment Canada requires scientific/technical skills in management. This is not adequately recognized in the set of competencies developed for senior civil servants, which is a barrier to the science-to-policy linkage.

Consultations/Openness:

- Environment Canada has a written policy on the web that reflects its pledge that "consultation is an interactive and iterative process that elicits and considers the ideas of people and provides opportunities to influence decisions before they are made";
- Written policy outlines the guiding principles, the characteristics of an effective consultation and participant funding guidelines (see appendix for more information);
- Tools for departmental practitioners planning and managing consultations are available

(consultations calendar, electronic network for sharing of experiences, a Guide to Public Involvement).

### 3. *Current Issues*

Guidelines:

- High degree of comfort with science guidelines analogous to those in the UK. Senior officials believe it is important to recognize the need to customize for different operating environments.

Capacity:

- Serious capacity problem. Both emerging areas of importance (biotechnology) and in ability to maintain core monitoring activities needed for mandate (e.g., toxic chemicals in the environment, Fisheries Act).
- While regulatory responsibility is moving to the provinces, the provinces themselves are reducing science capacity, adding pressure to the federal side.
- Social sciences capability weak; needs strengthening.
- Significant concerns with capacity to deal with boundary problems (prov-prov or Can- US).
- International/foreign affairs - critical need for more capacity to analyze some of the international agreements before they are signed. Also, for international negotiations on trade agreements etc., need to be able to sense the currents at play among nations, including the science issues and their implications. Environment Canada as the substantive department should likely play a more dominant role.

Science Assessment as a bridge between science and policy:

- A recently commissioned report (Bush, 1998) on the science to policy linkages in the Atmospheric Environment Service (AES) identifies a number of key barriers and recommendations for improvement.
- The proposed directions of evolution are convergent, if more specific in nature to the type of activities within AES, with the science guidelines issued in the U.K. The full set of recommendations is reproduced in the appendix to this profile.
- The report also proposes a framework for science assessment that would function as a bridge between science and policy - a four phase process:
    - science review and assessment;
    - synthesis;
    - policy integration;
    - science and risk communication .

  The defining characteristics of each phase are summarized in the appendix to this profile. Science and risk communication is assessed as the least well-developed phase.

## 4. Documentation

- *Environment Canada's Science and Technology: Leading to Solutions*. March 1996. Outlines the departments mission and new directions following program review.

- *Performance Report For the Period Ending March 31, 1998*. Environment Canada web site. http://www.ec.gc.ca

- *Our commitment to effective consultations*. May 27, 1996. A policy that articulates the guiding principles and practices of consultations that provide public involvement for all facets of EC's activities. http://www.ec.gc.ca/consult/policy_e.html

- *Management Framework. Science and Technology*. November 1998. Document designed to guide the management of S&T within Environment Canada - the "how" within the directions established in strategic and business planning activities. It sets out the principles, elements and management tools that have been adopted or are under development.

- *Framework for External Review of R&D in Environment Canada*. Draft version - October 29, 1998. Presents the operating policy (and guidance on implementation) for a formal system of regular expert review of the departmental R&D.

- *Environment Canada's Scientific Research Publications in 1995*. Report to the Science Policy Division June 1998. A quantitative overview of EC's production of scientific knowledge in 1995 - publications, collaborations, international rankings.

- *Biodiversity in Canada: A Science Assessment - Summary*. 1994. A review of the state of knowledge on biodiversity in order to identify implications for policy and for further research.

- *Briefing Note: A Science Assessment Process - Atmospheric Issues*. November 1998.

- *Science Advice in Government. March 1998*. Internal briefing note on science advice in government, including a focussed look at the role of science assessment in science advice for government decision-making and recommendations on the topic by the EC R&D Advisory Board.

- *Measuring the Impacts of Environment Canada's R&D. Case Study: Pulp and Paper Effluent Research*. Report to Environment Canada (Marbek Resource Consultants in association with Secor Inc.), September 1997.

- *Measuring the Impacts of Environment Canada's R&D. Case Study: Stratospheric Ozone Depletion Research*. Report to Environment Canada (Marbek Resource Consultants in association with Wintergreen Consulting), May 1998.

- *Science Assessment. A Report on Science-Policy Linkages in the Atmospheric Environment Service*. Elizabeth Bush, November 1998.

- *A New Vision for State of the Environment Reporting*. Draft text December 1998. Prepared by the 4NR MOU ad hoc SOE group. Designed to develop common approach for presenting policy driven science assessments within the framework of a coordinated State of the Environment reporting program. Document addresses the minimum content and presentation criteria for an SOE report and an internal validation process. Initiative appears to be voluntary.

## *Appendix - Environment Canada*

### *S&T Management Framework - Environment Canada*

Goals of S&T Management:

1. to promote excellence in the performance of environmental S&T in the department;
2. to ensure that S&T activities are clearly linked to broader Departmental planning and priorities;
3. to ensure that S&T is effective and that opportunities for integration of S&T conducted throughout the department exist;
4. to ensure that S&T within the department is conducted in a manner that promotes the public good;
5. to give S&T employees opportunities to grow, develop skills and be challenged;
6. to ensure accountability for the delivery of S&T throughout the department;
7. to listen and respond to stakeholders, clients and partners;
8. to monitor the effectiveness of the management of S&T resources at Environment Canada;
9. to promote continuous improvement in the management of S&T at Environment Canada.

Framework Elements for S&T Management:

1. The S&T management system - committee structure.
2. Strategic planning, coordination and integration - processes for identification of long-term requirements and establishment of S&T objectives and priorities to meet mandate.
3. Accountability - establishment of responsibility centres and description of methods and guidelines for measuring effectiveness of S&T programs and services.
4. Partnerships and alternate service delivery.
5. S&T operating practices - for undertaking and delivering S&T activities, including IP management, peer review, cross appointment practices, technology development, etc.

6. Managing S&T human resources.
7. Communicating S&T - reporting to and communicating with partners, stakeholders and the general public for a broad understanding of key findings.

***Consultations - guiding principles (web site)***

1. Building relationships and trust - Open channels of communications and constructive working relationships with organizations, partners and clients are valued as a key foundation for effective consultations.

2. Influencing decisions - Consultations will be designed as an integral part of the decision making process. The process will be transparent and consultations will take place while options are still open.

3. Balancing listening with leadership - Environment Canada information, knowledge and positions will be shared openly and in a timely fashion with those being consulted. Consultations will be balanced with getting things done.

4. Tailoring our approach - Consultations will be tailored to reflect the particular circumstances and variables of the decisions at hand.

5. Striving for greater effectiveness - Consultations led by Environment Canada will be designed with a view to make the most efficient use of existing mechanisms and internal resources while maximizing the contribution of participants.

6. Adhering to high quality and performance standards - Consultations will be planned, carried out and assessed based on the best practices in the field. Environment Canada has adopted the Guide to Public Involvement, a national standard of Canada published by the Canadian Standards Association (March 1996), as its benchmark for effective consultations.

***Recommendations to Environment Canada regarding Science - Policy Linkages in the Atmospheric Environment Service (Bush 1998)***

Time frame disparity:

1. Scientists must recognize that policy makers cannot wait for resolution of all scientific uncertainty and therefore must document clearly how the uncertainty limits decision making, and the timeframe for resolving the uncertainty. In the meantime, interim advice arising out of the science that would be prudent to follow, should be clearly communicated.

2. A political commitment is required to support assessment program on a long-term basis so that the science is in a process of constant evolution and directed towards answering policy needs even during period of relative inattention on the policy front. This should help minimize the disparity in timeframes for development of science and policy.

3. Communication strategies should be linked to assessment processes and should specifically include communication of the processes underway to address risks to public health and the environment in order to create understanding among the public regarding any delays in the development of policy on these issues.

Engagement of the scientists:

4. A mechanism for rewarding the contribution of government scientists to assessment work needs to be formalized in the promotion system, and the fact that this has been said before and yet still arises as a problem, indicates that little has been done to date to rectify this recurrent problem.

5. The critical role of the assessor in coordinating the science review stage, thus facilitating the participation of scientists and freeing them of administrative responsibilities related to the assessment, should be recognized and appropriately resourced.

6. Where appropriate, assessment documents should be published as a collection of peer reviewed papers in an internationally recognized journal, although the trade off may be that "integration" of the document is sacrificed to some extent. Alternatively, review papers could be written by experts, which would themselves be publishable. The assessor would then assume the task of writing the assessment document with the review paper as reference material. At a minimum, chapter authors should be identified and where possible, individual chapters in an assessment document should undergo peer review, to facilitate accreditation of the work and subsequent publication of the work by the scientists themselves in the scientific literature.

Resourcing of science reviews and assessment documents:

7. Assessments should be sufficiently resourced to allow the assessor to contract authorship of sections of the assessment documents. This would encourage the participation of experts and also impose more control over the process, including over the imposition of deadlines.

Responding to research needs:

8. As part of the science assessment process a mechanism should be put in place to coordinate a research program (which may often be inter-departmental in nature) that will follow through on

areas of research identified in the assessment document.

Synthesis:

9. The production of synthesis type documents should become a formal component of Science Assessment. It should also be recognized that such documents are unique undertakings, and that they serve a communication function beyond that of executive summaries, both for the policy community and the general public.

10. Involvement of the policy community in the preparation of synthesis documents is critical to ensuring that the science advice is communicated in a manner that facilitates its incorporation into policy making.

Role of the assessor:

11. The role of the science assessor should be formally acknowledged and the position should be adequately supported in recognition of the critical function served by this person in communicating science advice to policy makers.

Characterization of scientific uncertainty:

12. The nature and scope of scientific uncertainty and the implications of this uncertainty for decision making must be addressed as part of the science advice to policy makers. Also, scientists must be clear about where the science provides definitive answers and on the contrary, where some element of subjective decision making in the form of professional judgement was required.

Participation of scientists in the policy process:

13. Scientists (and the science assessor) should be actively involved in the process(es) established for developing policy on an issue to promote the integration of science into decision making (i.e., the science assessment process cannot be seen to end with delivery of the assessment and synthesis documents to policy makers).

14. Given that the revised PSL2 assessment process by Environment Canada has taken steps to involve policy makers (Risk Managers in this case) in their science assessment process and likewise to involve scientists in the risk management phase, consideration should be given to evaluating the success of this process in light of the upcoming completion of a number of PSL2 assessments under the new process.

Role of science versus other factors:

15. The science assessor should be involved in the development and reporting of government policy decisions on science based issues, to ensure that the decision-making process is explicit with respect to the treatment of that science advice.

Lack of long-term commitment to science programs:

16. Science assessment should be a stimulant for a long term commitment to a science program, not an end in itself, with periodic reviews or updates of the assessment being a critical part of the process for tracking progress on an issue and providing some accountability.

17. Scientists should promote also the establishment of a science program, as part of Action Plans developed to address an issue. This will help establish the science assessment process as an iterative and cyclical process whereby anticipated policy needs are communicated to scientists and research programs are established to respond to those long term needs.

Responsibility for communication:

18. Consideration should be given to integrating a communication phase into the science assessment process in order to fulfill the responsibility of the government to educate the public about both the science and attendant risks of air pollution.

Need for coordinated and comprehensive communication strategies:

19. Development of a communication strategy should begin as early as possible in the assessment process and consideration of communication needs should become an integral part of each phase of the assessment process. Adequate resourcing of communication efforts is required to develop effectively and timely communication materials on which to base communication efforts.

20. The need for a communications expert should be recognized and sufficient resources should be provided to that person in recognition of their role, like that of a science assessor, in bridging the gap between the scientists and in this case, the general public.

Timing and form of stakeholder involvement:

21. There is a need to establish rules regarding the timing and form of stakeholder participation in science assessments and for these rules to be made clear to the stakeholder community. These rules should be consistently applied from one assessment to another. Thought should be given

to the costs and benefits of alternative approaches to stakeholder consultation.

Equity/inequity in stakeholder participation:

22. Measures to bring more equity into the process of stakeholder consultations are required and the resources required to do this should be considered when decisions are made regarding the timing and form of stakeholder consultation.

Framework for science assessment (Bush 1998)

| | Activity | Implications | Product and Audience |
|---|---|---|---|
| 1. Science review and assessment | | | |
| | Develop a state of the art understanding of all critical aspects of an issue, and of areas of uncertainty in a way that retains the integrity of the science, while rendering information useful for decision makers | Expert review; will involve scientists; may involve external stakeholders<br>Peer review of the output critical | Product - technical document<br>Audience - science community and science assessors |
| 2. Synthesis | | | |
| | Effectively and accurately synthesize complex science review into a concise summary that is understandable to non-scientists and to decision makers<br>Structured as a response to specific policy needs | Science assessor key<br>Extend scope of inquiry if needed<br>May involve stakeholders<br>Expert review (science and policy) of output wise | Product - concise document<br>Audience - policy community |
| 3. Policy integration | | | |
| | Integration of science into the deployment of policy, ensuring that the scientific basis for control measure is accurately represented and that implications of various control measures are understood | Science assessor and Policy issue manager key<br>Stakeholder participation important | Product - Action Plan laying out government response<br>Audience - public and regulated |
| 4. Science and risk communication | | | |
| | Communication about risks and risk management | Communications expert key<br>Link to various phases of the assessment process | Product - Information<br>Audience - The general public |

## Department of Fisheries and Oceans

### *1. Context for Use of Scientific Advice*

The DFO mission is to manage Canada's oceans and major waterways so that they are clean, safe, productive and accessible, to ensure sustainable use of fisheries resources, and to facilitate marine trade and commerce. The department defines five specific objectives:

- manage and protect the fisheries resource;
- manage and protect the marine freshwater environment;
- understand the oceans and aquatic resources;
- maintain maritime safety;
- facilitate maritime trade, commerce and ocean development.

Science advice for fisheries management is the most dominant "science in policy" issue for the department, followed by climate change. There is a long history of collectively reviewed science advice integrated into policy that evolved from the International Commission on North Atlantic Fisheries. When the fisheries jurisdiction was extended, Canada put in place its own committee structure that has evolved over the years with the most significant changes in practice occurring during the 1990s, especially in the last two years. There remains a significant international element in the management of fisheries stocks.

The collapse of the East Coast cod fishery, and the public debate between Hutchings et al (1997) and the Department (see articles by Healey and Doubleday and Parsons) have focused media attention on the Department and its decision-making process. Changes in the procedures of stock assessment and quota allocation had been initiated prior to the most public debates, but the process of change has been slow, with the West Coast reforms only just being introduced at the time of this report. There has been a significant increase in transparency and community involvement. The overall context for decision-making has also evolved by virtue of the change in departmental philosophy from maintenance of the fishing community to stewardship of the resource.

At the present, the impact of science advice in DFO is described as being very direct. Scientific advice is normally a constraint on decision-making. Minisers are very reluctant to go against science advice.

### *2. Practices and Procedures*

Science input derives primarily from both DFO scientists and partnership programs (such as the Sentinel Survey Program) that is a cost shared program of DFO and external stakeholders, utilizing commercial vessels in survey work.

The process of fisheries decision making on quotasand conservation measures has three main elements:

- Regional Resource Assessment Process (RAP) - compilation, interpretation, validation and integration of information on stock assessment, that includes a "peer review process" coordinated by the Canadian Stock Assessment Secretariat.
- Fisheries Resource Conservation Council (FRCC) and other mechanisms that involve some public consultations and recommend total allowable catches and other conservation measures (FRCC currently in place in the Atlantic and being established on the Pacific).
- Arrangements in the North are somewhat different, with the Management Board (which has a significant representation of Aboriginal interests) having a major say in decisions. The Minister does, however, have a veto power over decisions.

There are explicit guidelines for the conduct of the RAP peer review processes (which vary among the regions and among stocks). Key features include:

- Participation of DFO staff (any employee may participate; key scientists are expected to justify their science and interpretations in this public forum);
- DFO Chair;
- External participation (full participation in the process and decision making, with access to all documentation) by invitation of individuals from the fishing industry, academia, other government departments, public interest groups and the general public. Invitations based on individual merit. DFO does not normally reimburse travel costs for outside participants;
- Outcomes include statements of divergent views with supporting and contradictory evidence for each, levels of uncertainty and risk;
- Public release of results of RAP meetings as stock status reports quickly after the RAP peer review (on web site within days of the peer review);
- An audit trail is maintained of draft documents and edits;
- If there is a high level of public interest, there would be a press release immediately after the peer review (Chair of peer review committee is the spokesman).

DFO documentation provides guidelines on the desirable characteristics of participants, including knowledge, stature, understanding of peer review and a diversity of opinions (including traditional knowledge). The guidelines also state that "to assure the perception of objectivity of the RAP process, individuals widely recognized as strident advocates of narrow perspectives or specific sectoral interests generally are not selected."

A Fisheries Resource Conservation Council (FRCC) was established on the East Coast in 1993; a West Coast Council under the Chairmanship of John Fraser is being created at the time of preparing this report. The FRCC is a partnership between government, the scientific community and the direct stakeholders in the fishery. The mandate and objectives are reproduced in the appendix. FRCC reports are on the web.

Independent external review panels are used from time to time for review of major issues of significant public interest, e.g. Dr. Les Harris (Independent Review of the Status of the Northern Cod Stock) and

the Hon. John Fraser (Fraser River Sockeye Public Review Board). They are seen as being good at providing high quality credible advice on difficult issues, but costly and slow.

Publication policy:

- Internal peer review before going to publications - i) other scientists and ii) departmental management - to ensure that the paper is accurate, clear and well-written, the findings are supported by the data.

External review of science units:

- External reviews are carried out "as needed" according to the call of a manager or the DFO senior officials. There is no systematic external review of all science operations on a regular basis, other than the normal review by federal auditors and evaluators.

Preparation of policy documents:

- Done in headquarters, where there are science advisors who work with Fisheries; Management in drafting Memoranda to Cabinet and other policy documents;
- Memo to Minister typically signed off by the science sector.

### *3. Current Issues*

Resource management:

- Continuing resource management issues relate to the East Coast - seals and cod - and the West Coast salmon fisheries.
- The opening up of the RAP process and the creation of a somewhat differently structured FRCC on the West Coast are seen as means to tackle this.
- While there is significant support for the direction of change, there is some concern with the Resource Assessment Process in that it has institutionalized a regional approach to management of a stock that is not itself regional. Example - stocks in the Gulf and in Newfoundland.

Public trust:

- A significant issue is rebuilding the public trust following the public storm fueled by publicly stated concerns from the scientific community regarding muzzling and misrepresentation of data. DFO suggests that some DFO scientists appear to be developing a higher comfort level with the process. There is evidence that there is less discomfort than in the past, although the external research community continues to be wary of DFO headquarters.
- International comments suggest that more external insights (non-Canadian) in the stock assessment process could be useful to keep all honest.

Structural:

- There is concern that the actual structure of DFO - the separation of science from operations - is a systemic problem, creating barriers where there should be cross walks between science, operations and policy. The connection of science with the industry should also be promoted, all of which would instill a stronger linkage of policy and science.
- The Minister of Fisheries has enormous responsibilities. Is this reasonable? The Fisheries Act is pervasive. In Australia some of the responsibilities have been farmed out to an arms length body with executive power. Should Canada look at a comparable approach?
- Where is the oceans component of the mandate? It tends to get swallowed by the more controversial fisheries side.

Nature of science advice:

- In terms of the nature of science advice, DFO has moved from single species biology to taking some account of the broader ecosystem interactions in the stock accounts. However, risk calculations still relate primarily to single species. Explicit recognition of risks and uncertainty is handled through the use of graphs of probability of stock increases versus catch level. Non-specialists appear to have little trouble with the concept of probabilities.
- There are no comprehensive, quantitative ecosystems models, but many scientists advocate an aggressive move from what is now being described as a population dynamics approach within DFO to ecosystem based management.

## *4. Documentation*

- DFO Mission, mandate and long-term priorities http://www.dfo-mpo.gc.ca/dfo_mpo/mandat_e.htm

- Fisheries Resource Conservation Council - description, mandate, membership. Http://www.dfo-mpo.gc.ca/frcc/Baseinfo/terms_of_reference.htm

- Regional Resource Assessment Process
    - Overview of the RAP process across regions and species groups. DFO (undated);
    - Outside participation in peer review sessions. DFO guidelines (undated).

- Canadian Stock Assessment Secretariat
    - Terms of Reference. DFO (undated);
    - Description. DFO undated.

- Sentinel Survey Program
    - Sentinel Survey 1998. Update for FRCC. October 1998.
    - 1997 4VSW Sentinel Program. Program description. A Joint project of Fishermen and Scientists Research Society and Marine Fish Division, DFO Science Branch.

Agreement on program to monitor fish stocks, migratory patterns, fish populations and dynamics, and to engage in co-education.

- *Report of the Sentinel Survey Programs in the Canadian Atlantic 1994-1996.* G. Chouinard, B. Davis, P. Fanning, T. Lambert, and A. Fréchet. DFO publication. June 1997.

- Group of papers dealing with issues of scientific freedom
  - Hutchings, J.A, Carl Walters and Richard L. Haedrick. *Is scientific inquiry incompatible with government information control?* Can. J. Fish Aquat Sci. 54: 1198-1210 (1997) .
  - Doubleday, W.G., D.B. Atkinson and J. Baird. *Comment: Scientific inquiry and fish stock assessment in the Canadian Department of Fisheries and Oceans*. Can J. Aquat. Sci. 54: 1422-1426 (1997)
  - Healey, M.C. *Comment: The interplay of policy, politics and science*. Can J. Fisheries and Aquatic Sci. 54: 1427-1429 (1997).
  - Rowat, W.A. Deputy Minister's letter to National Research Council June 1997.
  - Parsons, L.S. *A Perspective on Department of Fisheries and Oceans Science* (Response to a Canadian Press Story June 21) DFO web site.

**Appendix - Department of Fisheries and Oceans**

***The Fisheries Resource Conservation Council***

Mission

To contribute to the management of the Atlantic fisheries on a "sustainable" basis by ensuring that stock assessments are conducted in a multi-disciplined and integrated fashion and that appropriate methodologies and approaches are employed; by reviewing these assessments together with other relevant information and recommending to the Minister total allowable catches (TACs) and other conservation measures, including some idea of risk and uncertainty associated with these recommendations; and by advising on the appropriate priorities for science.

The Council Objectives

Note - the following objectives include a number of activities directly related to the management of science for policy and decision making.

- To help the government achieve its conservation, economic and social objectives for the fishery. These conservation objectives include, but are not restricted to:

    - rebuilding stocks to their 'optimum' levels and thereafter maintaining them at or near these levels, subject to natural fluctuations, and with 'sufficient' spawning biomass to allow a continuing strong production of young fish; and
    - managing the pattern of fishing over the sizes and ages present in fish stocks and catching fish of optimal size.
- To develop a more profound understanding of fish-producing ecosystems including the interrelationships between species and the effects of changes in the marine environment on stocks.
- To review scientific research, resource assessments and conservation proposals, including, where appropriate through a process of public hearings.
- To ensure that the operational and economic realities of the fishery, in addition to scientific stock assessments, are taken into account in recommending measures to achieve the conservation objectives.
- To better integrate scientific expertise with the knowledge and experience of all sectors of the industry and thus develop a strong working partnership.
- To make public recommendations to the Minister.

Constitution of Council

Different constitution on east and west

- 14 members, selected on individual merit;
- East Coast - does not include NGOs;
- East Coast - each of 4 Atlantic provinces nominate one delegate (who do not formally endorse recommendations).

***Publication Policy for Maritimes Region***

Scientific communication is the essential element of the scientific process. The purpose of this policy is to encourage Science staff to disseminate their findings through written and oral presentations that meet the high standards of scientific communication. An ancillary purpose is to ensure that communications that address sensitive issues or that can be construed to contradict Department policy are identified in a manner that permits the Department to respond in a timely fashion after the issue or article has been made public.

This policy recognizes the primacy of the peer-review system in maintaining scientific standards and establishes separate manuscript submission and review processes for primary, secondary, and RAP publications. The policy also establishes procedures for oral and poster communications. A diagram which provides an overview of the procedures described below is attached.

**Procedure for Submission of Manuscripts as Primary Publications**

Primary publications refer to scientific journals, special issues, books, and conference proceedings in which submitted manuscripts are reviewed by independent referees appointed by an editor. The procedure for submission of manuscripts intended for primary publications is:

1. This procedure only applies to manuscripts where the senior (first) author is an employee of the Department and/or where a significant amount of DFO resources has been expended in its production.
2. Prior to the submission to the journal editor, the author should have the manuscript reviewed for scientific content by at least two qualified experts. It is the responsibility of the author to select suitable reviewers who should be informed of the journal name and format to which the manuscript will be submitted. The names of the reviewers are to be recorded on the Manuscript Record form, a copy of which is attached.
3. The author submits the manuscript to the Division Manager, along with the Manuscript Record form. The latter examines it for statements that may address sensitive issues or contradict the current Department policy, or for use of proprietary data and/or information.
4. If no controversial or sensitive material is identified, the Division Manager signs the Manuscript Record form, returns the form and manuscript to the author, and forwards a copy of the Manuscript Record form to the Regional Director of Science's office.
5. In the rare case where controversial or sensitive subjects are identified, the Division Manager first consults with the senior author to confirm the intent of the manuscript. If there are no changes, the Division Manager signs the Manuscript Record form, sends it and a copy of the manuscript (with a note that the manuscript contains sensitive subjects) to the Regional Director of Science. The Regional Director of Science signs the Manuscript Record form and returns it to the author but may retain the copy of the manuscript. If the author wishes to make changes, these are made and then the process proceeds as in (4).
6. In the rare case where an author has used proprietary data and information, the Division Manager and the Regional Director of Science shall withhold permission for the paper to be submitted for publication until appropriate written permission to use the data in the publication is obtained from the owner of that data.
7. A limit of ten working days is given after the time of submission of the manuscript by the author to the Division Manager to identify potentially sensitive issues. Regardless of the outcome of this review, after ten working days, the author can submit the manuscript for publication without waiting for the Manuscript Record form to be returned by either the Division Manager or the Regional Science Director's office.
8. In the case of publication of personal opinions and commentary, and assuming the manuscript is

accepted for publication, the Regional Director of Science retains the right to request a disclaimer be included with the final revision, e.g., "The opinions and conclusions contained in this paper do not necessarily reflect the current policy of the employer". The disclaimer would be placed on the title page of the final revision of the manuscript that is sent to the journal.

9. One reprint of the published paper should be forwarded to the Regional Director of Science's office and one to the Division Manager's office.

**Procedure for Submission of Manuscripts as Secondary Publications**

Secondary publications include Canadian Technical Reports of Fisheries and Aquatic Sciences, Canadian Data Reports of Fisheries and Aquatic Sciences, Canadian Industry Reports of Fisheries and Aquatic Sciences, and Canadian Manuscript Reports of Fisheries and Aquatic Sciences. These documents often contain preliminary findings and appropriate disclaimers are frequently included for individual publication series. The Department normally provides the only review for these documents. For the purposes of this publication policy, RAP documents, such as status reports, proceedings and research documents are not included under this heading. The procedure for review of manuscripts intended for secondary publication is:

1. This procedure only applies to manuscripts where the senior (first) author(s) is an employee of the Department.
2. It is the responsibility of Division Managers to either appoint an individual in their division as a Secondary Publications Editor or fulfill this task themselves. In either case, this individual is responsible for quality assurance of secondary publications produced by the division.
3. The author submits the draft manuscript to the divisional Secondary Publications Editor.
4. The Editor forwards the manuscript to two reviewers where appropriate (e.g., Canadian Data Report of Fisheries and Aquatic Science normally requires no review), who may be either internal or external to the Department. Reviewers are asked to evaluate the scientific content of the manuscript, to document their comments and to recommend: (i) acceptance of the manuscript; (ii) acceptance following appropriate revisions; or (iii) rejection.
5. On the basis of reviewers' comments, the Secondary Publications Editor either accepts the manuscript as is, specifies the revisions required, or rejects the manuscript. The author is informed of the decision and if changes to the manuscript are required, the author makes these before resubmitting it to the Secondary Publications Editor.
6. Upon receipt of the final version of the manuscript, the Secondary Publications Editor signs the Manuscript Record form and submits it and the manuscript to the Division Manager. The latter examines it for statements that may address sensitive issues or contradict the current Department policy or for use of proprietary data and/or information.
7. If no controversial or sensitive material is identified, the Division Manager signs the Manuscript Record form, returns the form and manuscript to the Secondary Publications Editor, and

forwards a copy of the Manuscript Record form to the author and the Regional Director of Science's office.

8. In the rare case where controversial or sensitive subjects are identified, the Division Manager first consults with the senior author to confirm the intent of the manuscript. If there are no changes, the Division Manager signs the Manuscript Record form, sends it and a copy of the manuscript (with a note that the manuscript contains sensitive subjects) to the Regional Director of Science. The Regional Director of Science signs the Manuscript Record form and returns the Manuscript Record form to the Division Manager, who then copies it to the Secondary Publications Editor, but may retain the copy of the manuscript. If the author wishes to make changes, these are made and then the process proceeds as in (7).
9. In the rare case where an author has used proprietary data and information, the Division Manager and the Regional Director of Science shall withhold permission for the paper to be submitted for publication until appropriate written permission to use the data in the publication is obtained from the owner of that data.
10. A limit of ten working days is given after the time of submission of the manuscript by the Secondary Publications Editor to the Division Manager to identify potentially sensitive issues. Regardless of the outcome of this review, after ten working days, the Secondary Publications Editor can submit the manuscript for publication without waiting for the Manuscript Record form to be returned by either the Division Manager or the Regional Science Director's office.
11. The Secondary Publications Editor then makes arrangements to have the manuscript published in the appropriate series. A "Record of Scientific Report" form (0844) is submitted to Headquarters to obtain a report number.

**Procedure for Submission of Manuscripts as CSAS Research Documents**

Research documents are produced as a result of the RAP peer review. Given that these documents have undergone an extensive peer review, the purpose of the internal DFO review is to ensure high quality of style, format and readership, rather than technical accuracy. The procedure for the review of these documents is:

1. This procedure only applies to Research Documents where the senior (first) author(s) is an employee of the Department.
2. The author first obtains a Research Document number directly from Canadian Stock Assessment Secretariat (CSAS) (613-992-0029), the governing agency.
3. The author submits the Research Document to the chair of the meeting at which it was discussed. The chair confirms that the technical basis of the status report produced by the meeting is covered in the document. In some instances, meeting chairs are individuals from outside DFO. In this case, the author can submit the Research Document to his/her Division Manager, who is responsible for confirming that the technical basis of the status report is covered in the document.

4. The meeting chair arranges for the Research Document to be reviewed to ensure the style, readability and format of the document, but not its technical merit which has already been reviewed at the RAP meeting. Divisions are free to define the editorial process to fulfill this function. Once this editorial review is complete, the meeting chair completes the Manuscript Record Form, attaches it to the Research Document and returns the document to the author, who is responsible for incorporating any identified changes.
5. The author submits the final manuscript to CSAS, and sends a copy along with a completed Manuscript Record Form, to his/her Division Manager for filing.

**Procedure for Review of RAP Stock Status Reports and Proceedings**

RAP Status Reports and Proceedings are produced as a result of the RAP Peer Review process. Given that these documents have undergone an extensive peer review, the purpose of the internal DFO review is to ensure high quality of style, format and readership, rather than technical merit. The procedure for the review of these documents is:

1. The Regional Director of Science has delegated final approval of Status Reports and Proceedings to the RAP meeting chair.
2. The documents are provided by the meeting chair to the RAP Coordinator, who arranges an Editorial Board meeting. The Board is chaired by the RAP Coordinator, and consists of the relevant meeting chair and the author(s) of the status reports under review. Notice of an Editorial Board meeting is copied to members of the RAP Coordination Committee in the event they wish to participate. Individuals, such as regional scientists and members of the fishing industry can be requested to assist the board in its editorial function.
3. In the case of status reports, if substantive comments are made at the Board meeting, the meeting chair may wish to reconvene the subcommittee to review the comments. Otherwise, the comments are incorporated into the status report by the author(s). The status report is then returned to the meeting chair, who approves the final product, and sends the document to the RAP Secretariat, which arranges for the translation, distribution and transmittal of the document.
4. In the case of Proceedings, editorial comments are addressed by the chair and the document then provided to the RAP Secretariat for further processing.
5. The RAP meeting chair prepares a briefing note, based on the Summary section of the status report, for transmission through DFO line management. These documents are needed to brief DFO and the Minister prior to public release of the status reports.

**Procedure for Review of Oral Presentations and Posters**

Oral presentations and posters take several forms. One type of oral presentation includes those invited at various institutions within or outside of government and can take the form of lectures, seminars, round

tables, industry consultations, etc., where no abstract is produced. More formal oral presentations usually require that an abstract be submitted for dissemination before the conference, workshop, or symposium. Usually, posters presentations are restricted to conferences, workshops, and symposia and require submission of an abstract to be circulated before the meetings.

The supervisor should be apprised of the title of the presentation, date, location, and a brief outline of the topics to be covered. On rare occasions, the supervisor may advise the speaker that they are dealing with sensitive issues, identify the specific issues, and suggest how the speaker should handle the matter, especially if members of the media could be present. It is expected that the speaker will stay within his/her area of expertise.

A copy of all abstracts should be sent to the Division Manager's office who will forward a copy to the Regional Director of Science's office.

**Controversial or Sensitive Material**

It is incumbent upon the Division Manager to identify those instances where a publication contains actual or potentially controversial or sensitive material. It is then the Division Manager's responsibility to develop a communications plan to deal with this potential issue. At no time will the potential controversial/sensitive nature of the publication restrict, restrain or retard the author(s) ability to publish.

## Health Canada

### *1. Context for Use of Scientific Advice*

Health Canada's mission is to help the people of Canada maintain and improve their health. That mission is delivered through a matrix of six business lines and eight organizational structures, all of which involve a significant interplay of science and decision-making. In partnership with provincial and territorial governments Health Canada develops health policy, enforces health regulations, and contributes to disease prevention and control and promotes healthy living.

Health Canada officials estimate that more than 50% of its science capacity is deployed to broad support of Public Health Acts; and the remainder to the Health Canada mandate more generally. This more discretionary 50% relates to leadership (including future vision) and coordination functions of the departmental mandate.

The Health Protection Branch (HPB) is the most science intensive of the Health Canada Branches. It has the responsibility to:

1. assess the safety, effectiveness and quality of drugs and medical devices;
2. protect Canadians from potential health hazards associated with tobacco, food, radiation-emitting devices, certain consumer products and working and living environments;
3. develop and enforce regulations under consumer and environmental protection laws;
4. carry out surveillance and risk assessment activities to prevent and control diseases of national and international concern.

The Health Promotions and Programs Branch (HPPB) and the Medical Services Branch play a national role in enhancing the physical and mental health and well being of Canadians. By focussing on factors that influence health during childhood, adolescence, mid-life and later life, the HPPB works toward improving the health of these population groups. The Branches incorporate a significant social science research activity that is a key component of the departmental science capacity. There are additional activities relating to the capacity for strategic and evidence-based decision making within Heath Canada and in the Canadian health system through the Policy and Consultation Branch. These also draw on a social science base.

The Pest Management Regulatory Agency (PMRA) is part of HC and reports to the Deputy Minister. Although the agency does not have laboratories, it evaluates pesticide submissions, a related scientific activity (RSA). PMRAs activities are captured under the Business Line "Management of risks to health".

Given the dominance of public concern with health and safety, and the concentration of the science based decision making in this Branch, the profile deals primarily with the Health Protection Branch.

*The Health Protection Branch Transition*

Health Canada is responding to a number of challenges and emerging issues by developing a management system which is more accessible, open and transparent to the public and stakeholders. Health Protection Branch (HPB) Transition is a three-year process to strengthen and modernize the way Health Canada approaches and implements its health protection policies and activities. Consultations are a cornerstone of the Transition process which continues to include staff across the department, a wide range of stakeholders and the public across the country. The HPB Transition will result in a number of proposals to renew the health protection program:

- a decision-making framework and process that is transparent and open to public and stakeholder input;
- a legislative framework that provides the necessary authorities to protect the health of Canadians;
- a comprehensive Risk Management Framework that is clear on the accountability of HPB scientists and managers;
- access to leading-edge science in laboratories and through national and international networks;
- stronger surveillance tools to link local, national and international public health authorities, in order to improve the response time and to track disease and other risks to health;
- integrated programs that respond to current and emerging health issues whose effectiveness can be measured and evaluated.

The current legislative framework is a significant impediment to good decision-making. It is characterized (Shared Responsibilities Shared Vision) by the following:

- some laws are irrelevant or outdated, including their applicability to newly emerging pathogens, the ethics of bioengineered products, human organs;
- fragmented and inconsistent legislation, e.g. that provides an awkward framework for dealing with current consumer products and therapeutic goods (e.g. the blurring of the lines between drugs and medical devices);
- flexible and innovative responses to new and emerging issues are inhibited, e.g. new pathogens like the Ebola virus;
- the patchwork quilt of laws provides a poor basis for policy making;
- lack of recognition of the importance of risk management, and the concepts of population health and sustainable development.

Two consequences of the present legislative framework reveal the societal impact of the rigid legislative framework. First, the normal decision making process on a drug such as rBST is focussed on scientific considerations. The current regulatory framework, as depicted in the Food and Drugs Act and Regulations, restricts the decision criteria to a science-based audience, thus not providing for balanced

inclusion of broad ethical and social values (although in therapeutics, drugs must go through an ethics board before approval). Secondly, Health Canada cannot initiate a drug approval process. Regardless of the potential value of a new product to Canadians,
its approval can only be triggered by a private sector application.

## *2. Practices and Procedures*

Policy framework:

- Policy framework for science based decision-making articulated and on the web site (see appendix); it is under review for further refinement in light of changing health and regulatory paradigms (especially risk assessment/management).
- Key issues for the department are in how policy framework is implemented and in the legislative context for departmental operations.

Risk assessment/management:

- Along with CFIA, DFO and Environment Canada, Health Canada is one of the most significant players in risk assessment within the federal system of SBDAs.
- Health Canada is taking the lead on an interdepartmental discussion on risk assessment/management. A December 4, 1998 presentation to Science ADMs proposed a formalization of the process, involving partnerships with other stakeholders, consideration of the full range of appropriate criteria, identification of the roles and accountabilities of all players, and making uncertainties and assumptions explicit. The elements of this risk assessment/management approach are outlined in the Appendix.
- Proposed criteria for decision making:
    - health and safety;
    - social/cultural including impacts on communities;
    - environment/sustainable development;
    - ethical, especially with new technologies;
    - economic, including analysis of how to mitigate risks;
    - other.

Precautionary Principle:

- Key concept for Health Canada.
- Effectively means acting on issues that are expected to have policy significance before all of the data are available. Requires a capacity to act.
- Requires a cultural change on the part of scientists and the department. To operationalize need to change decision frameworks, in particular the risk management information and surveillance systems.

Identifying emerging issues:

- Capacity limited at present; Science Advisory Board seen as critical element.
- HPB has implemented a means of flagging potentially controversial issue within the Branch on a regular basis (building in accountability for "risk identification").

Source of Science Advice:

- In house science and risk assessment; much of data from private firms seeking approval.
- On contentious issues HPB uses various mechanisms for external advice, including independent expert panels. These have been found to be valuable both for accessing "the best" science and for providing the political decision makers with public confidence in the quality and independence of the science advice.
- Departmental thrust to access more advice from off shore and to improve linkages of in-house and external experts.

Quality Assurance:

- Expert advisory groups are used - e.g. therapeutics, HIV, immunization. Intend to use more; some organizational units do not have a tradition of using external advice; this is expected to change.
- Publication record of individual scientists.
- HPB considering initiating a regular process of peer review of all units. Some discussion of putting a request to MRC for acting as an independent agent for such reviews.

Transparency:

- There is a formal policy on publication; scientists expected to publish their work; science is vetted within the unit prior to submission to a journal.
- Use of web site for decision documents and supporting reports.
- Recognition of too much in-house focus on right of HPB to do risk assessments and make decisions. This is being moved to a more open interactive process to engage partners and make process more transparent.

### 3. *Current Issues*

Culture for science within HC:

- Significant morale problems among scientists. Recognized by management. Possibility of appointing a Chief Scientist to address.
- Among the scientists, at least, there is a perception of a negative connotation associated with the use of the word "research". Question of whether research and to some extent science is valued.

Capacity:

- Estimate by senior officials that Department has inadequate capacity to deal with its mandate.

Assessment of the current challenges of science decision-making in Health Canada:

- Generally science is used effectively in day to day decisions in the context of the regulatory mandate. The problems come with the larger/broader policy issues - where there should be a stronger science - policy linkage and an earlier flag of sensitive issues.
- Policy decision-making at the macro level is seen to have been too disconnected from senior levels of the department and minister (potentially controversial or explosive issues have not moved high enough fast enough). The delegation to scientific units, and the configuration of the program units, has translated to disconnections. Need a process that allows science managers to differentiate between that which is normal business and that with policy implications and manage information and decision making accordingly.
- A review of some of the HC documents (e.g Performance Report) reveals relatively little reference to social science that is an important component of department's science capacity. Example - epidemiological studies dealing with aging and health data that inform the debate on home health care.
- Health Canada would have been aided by a vehicle for exposing and incorporating minority opinions into the policy-making framework.

### 4. Documentation

- *Health Canada Performance Report for the Period Ending March 31, 1998.* Web site for Health Canada http://www.hc-sc.gc.ca

- *Health Protection Branch Policy Framework.* Web site for Health Canada http://www.hc-sc.gc.ca. This is reproduced in the Appendix to the profile , given the number of policies that relate directly to the use of science in decision making.

- *Shared Responsibilities Shared Vision: Renewing the Federal Health Protection Legislation.* Government of Canada. 1998 (also available at http://www.hc-sc.gc.ca/hpb/transitn/index.html) This document identifies the constraints and problems associated with the current legislative framework under which Health Canada functions with particular reference to its inability to cope with the science and technology of genetic engineering and new pathogens. As a consultation document it poses a number of questions about the role of Health Canada and the appropriate legislative framework for Canada's future needs, including addressing issues of risk management, surveillance, communicable diseases, commercial products, therapeutic products, food, new technologies and emerging hazards and compliance.

- *Health Protection for the 21st Century: Renewing the Federal Health Protection Program*. Government of Canada 1998 (also available at http://www.hc-sc.gc.ca/hpb/transitn/index.html) The consultation document identifies five basic tools for an effective health protection system - science, surveillance, risk management, legislation and program development and poses questions, the answers to which are designed to shape the evolution of the health protection activities at Health Canada. Included are questions regarding the role of science in decision making, the rights and responsibilities of scientists in public health decisions, how independence and effectiveness is maintained when working in partnership with the private sector.

- Various items from the Health Canada web site, including the Terms of Reference - Science Advisory Board.

- *Risk Management and Science: Proposed Decision-Making Framework*. Presentation Deck December 4, 1998.

- *Report of the Canadian Veterinary Medical Association Expert Panel on rBST*. Prepared for Health Canada. November 1998.

- *Report of the Royal College of Physicians and Surgeons of Canada Expert Panel on Human Safety of rbST*. Prepared for Health Canada. January 1999.

## Appendix - Health Canada

### Risk Management - "Shared Responsibilities Shared Vision"

Risk management[4] is a scientific process for identifying health hazards and deciding what to do about them.

It involves several steps:
- identifying the public health issue (can be a disease, agent, product, process or behaviour);

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[4]Health Canada integrates its consideration of risk assessment and risk management, unlike some of the international literature.

- gathering information about the risk by studying, among other things, the size and nature of the potentially affected population, the specific nature of the risk and the conditions of exposure;
- identifying (and analyzing) options for dealing with the risk;
- deciding on a risk management strategy (the choice of strategies takes into account factors such as the severity of the risk, researcher's degree of confidence in their data, legal requirements, public perceptions and socio-economic considerations);
- putting the risk management strategy to work;
- evaluating the effectiveness of the risk management strategy.

## Health Protection Branch Policy Framework[5]

### *Priority Setting*

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To establish priorities on the basis of risk assessment and management, including consideration of benefits in the development of risk management strategies and to allocate resources accordingly.
2. To establish priorities for dealing with existing and potential health issues that are based on their potential impact on the health of Canadians and their potential for effective intervention, or their effect on Canada's health care system.
3. To establish health goals in the priority areas and monitor progress towards their achievement.

### *Risk Assessment/Risk Management*

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To follow a structured process of risk determination for the assessment and management of health risks.
2. To identify and define risks to the health and well-being of Canadians through:
    - multidisciplinary, population or incidence-based investigations;
    - monitoring and evaluation of products and production processes;
    - research and laboratory investigations; and
    - evaluation, synthesis and interpretation of evidence-based information.

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[5]Reproduced from the Health Canada web site

3. To quantify the relationship between health outcomes associated with the hazard, and exposure to the hazard and the level of risk involved.
4. To identify various courses of action that could potentially address health issues under review.
5. To assess possible risk management options in a consistent manner, taking many factors into consideration including health benefits.
6. To select, implement and monitor appropriate courses of actions.

***Regulatory Approach***

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To use a regulatory approach which is flexible enough to permit responsiveness to innovative and changing circumstances.
2. To promote voluntary compliance and, where necessary, to enforce compliance with regulations.
3. To provide a process for consultation in adopting regulations and to implement them fairly.
4. To achieve health and safety objectives while promoting, where possible, enhanced Canadian competitiveness.
5. To maintain an effective and efficient regulatory system that is in balance with those of competitor nations so Canada is not economically disadvantaged.
6. To harmonize, where possible, with international regulatory standards and requirements, to increase efficiency.

***Internationalization***

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To participate actively in the development and adoption of international health and safety standards to reduce health risks to Canadians.
2. To consult with, provide assistance to, and share information with, other national and international agencies. Liaison and collaboration with these agencies is necessary as global measures and information have a direct impact on the health of Canadians.

***Communication***

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To make decisions publicly accessible in a timely manner, including the rationale leading to the decision, within the parameters of the *Privacy Act* and *Access to Information Act*.
2. To communicate risks and benefits to the public, both general and target groups, to:
   - assist in informed decision-making, and
   - explain strategies and actions.
3. To increase understanding among Canadians so they can improve their health (individuals, families, communities) through informed decision-making.

4. To develop communication strategies for new and existing health-related knowledge based on the needs and understanding of our partners and individual Canadians. These strategies will:
   - communicate new and existing knowledge using a wide variety of media;
   - link new information with existing knowledge, enhancing its value; and
   - facilitate the use of new and existing knowledge.

### *Cooperation*

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To work in collaboration with stakeholders in the development and delivery of programs.
2. To work with international agencies, other federal departments, and other levels of government in reducing harm caused by the distribution and use of controlled drugs and substances.
3. To encourage cooperation with industry, stakeholders and the public.
4. To recognize and incorporate public expectations into public health and safety decisions.

### *Scientific Capability*

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To develop, maintain and support a credible and competitive core scientific capability for research, evaluation, analysis and inspection, in support of reducing and managing risks associated with health-threatening hazards.
2. To conduct and support research aimed at developing, testing and maintaining effective measures for improving the health and safety of Canadians, through the reduction and management of risks associated with health-threatening risks and identifying health benefits.
3. To provide competent service by recruiting, developing, maintaining and supporting a high quality, professional and appropriately trained workforce.

### *Management*

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To manage according to principles that provide clear direction and create and support an environment that encourages excellence.
2. To assess and choose courses of action which make the best possible use of available resources while providing maximum public health benefit.

### *Revenue Generation*

It is the policy of the Health Protection Branch, in fulfilling its mandate:

1. To identify opportunities for revenue generation so that health protection initiatives will:
   - minimize the direct or indirect negative impact on public health and safety, and

- provide an incentive for effective and improved program delivery.

## Natural Resources Canada

### *1. Context for Use of Scientific Advice*

Natural Resources Canada provides the knowledge and expertise for the sustainable development of Canada's natural resources and the global competitiveness of the resource and related sectors for the well-being of present and future generations of Canadians.

The department describes its business as bringing its strengths in science and technology to bear on the sustainable development of Canada's natural resources. It specializes in energy, minerals and metals, forestry and earth sciences, recognizing areas of federal responsibility in trade, science and technology, federal regulatory responsibilities, the environment, national data and statistics and the management of lands and offshore areas under federal control.

The four sustainable development business lines are:

- developing sound national policies and regulations for areas under federal responsibility;
- promoting Canada's international interests, whenever they relate to natural resources;
- conducting scientific research and transferring new technologies;
- building a national knowledge infrastructure on Canada's land and resources.

These Business Lines are delivered through four operational sectors - the Canadian Forest Service, the Earth Sciences Sector, the Energy Sector and the Minerals and Metals Sector.

The department is highly S&T intensive with close to 70% of the total departmental budget being devoted to S&T and of that 86% to R&D. This reflects the very different mandate and mode of NRCan in comparison, for example, with Environment Canada which has 27% of its S&T in R&D and the rest in "related science activities". NRCan's contributions to science based decision-making take the form of a sort of S&T knowledge infrastructure for the business of government, and generally require cooperation with other government departments and external stakeholders. This includes:

Policy and regulation:

- Development of natural resource policies and strategic framework (e.g the Minerals and Metals Policy);
- Review of federal acts in collaboration with other departments (e.g. the Canadian Environmental Protection Act);
- Administration of federal regulations (e.g. Explosives Act);
- Advisory role to Department of Indian and Northern Affairs on resource issues;
- Advisory role to Revenue Canada and the Department of Justice on resource-related tax issues.

International Issues:

- Contributions to formulation and implementation of the Framework Convention on Climate Change and the Global Convention on Biodiversity;
- Contributions to establishing and defending Canada's position on the UN Law of the Sea;
- Contributor to international work relating to a Global Forest Convention, waste and recycling issues;
- Harmonization of energy efficiency standards and regulations.

Science and technology:

- Science and technology relating to sustainable resource development for provincial clients (e.g. integrated pest management strategies).

## *2. Practices and Procedures*

NRCan as it exists today was forged following Program Review from a restructuring of a number of units and a decision to integrate the science and policy activities within each of the four sectors (at that time only the Canadian Forest Service had that structure). While there remains today a diversity of activities and cultures among the four operational sectors, the department has developed a comprehensive set of principles and practices as a unifying force for the conduct of its operations. Some of these guidelines are of particular relevance to science in government decision-making (see the Appendix to this profile where some or all of the more relevant guidelines have been reproduced for easy reference):

A The S&T Management Framework
B Coordination of S&T with policy activities
C Consultation through external advisory councils
D Consultation with clients and stakeholders on S&T programs
E Human resources management for S&T organizations
F Scientific assessment
G External S&T communications

Following program review the DM asked for strong linkage of policy and technology. The integration process forced a number of developments, including the strengthening of the client - supplier relationship. This developed more rapidly in some sectors than others. Those with a private sector client moved more rapidly, those with a government client are still evolving. Generally, however, there is a very strong planning ethic within the department that is attributed to a clarity of vision and purpose that was developed following the Program Review challenges.

Actual practice varies among the four sectors. In the following section, some sample issues and practices are profiled.

Anticipatory Capacity:

- Considered an essential capacity for a resource department; priority to strengthening what is seen as embryonic or inadequate capacity.
- Energy Sector already working on 2030 scenarios.
- Most other sectors moving horizon towards 10 to 15 years (longer for climate change).

Structural:

- Structural challenges vary among sectors. In the case of the Mining and Metals sector, a major challenge is the relationship with Environment Canada.
- CFS is attempting to overcome cultural and structural difficulties (science in the regions versus policy at headquarters) through identifying a science advisor for each major issue (e.g. biodiversity) responsible for linkages among science in networks, Ottawa HQ and other departments (these people come from a science background but are embedded in a policy environment in Ottawa).

Unit Reviews:

- The tradition of external peer review developed in the Geological Survey of Canada and managed in partnership with an "external review agency" has been adopted by the Earth Sciences Sector with a 5-6 year life cycle for each unit. The Canadian Geoscience Council frequently acts as external review agency, providing credibility and independence to the process. A generic terms of reference is appended for this process.
- Following the restructuring of Program Review, some sectors (e.g. the Canadian Forest Service) have not yet re-instated unit reviews. This is being planned with both science and policy dimensions.

Publication policy:

- Scientists are expected to publish.
- Peer review within department; fairly routine management sign off.

Source of advice:

- Variable practices among sectors. Minerals and metals has a long tradition of multi-stakeholder programs (e.g Mine Environment Neutral Drainage Program (MEND)) which engages external stakeholders in discussions on regulatory issues in the formative stage and involves partnerships in the development of science input.
- The Canadian Forest Service works closely with the provincial DM's of Forestry;
- Stakeholder consortia are used in some areas to bring private sector data to the table prior to drafting of regulation.

Cross cutting initiatives:

- Inter-departmental initiatives are important, but difficult.
- Climate change secretariat management that crosses vertical reporting lines; really difficult to get reporting/accountabilities right.
- The creation and functioning of the interdepartmental group of the five natural resource departments was characterized as a major milestone in planning and cooperative initiatives (in science and in using science).

Staff Training:

- CFS has developed a series of workshops targeted at bridging the science to policy cultural divide. Drawing insights from earlier surveys of scientist and policy perspectives, a set of resource materials and a workshop protocol was developed that was designed to expose the two communities to the actual task of devising science-based policy through case studies and role playing.
- Workshops delivered in the regions, not headquarters.

Communications with the press:

- All scientists are expected to be available to speak with the press, with the only requirements being to keep to NRCan activities, speak with the media shop immediately after interview with press, avoid commenting on policy or provincial decisions.

### 3. *Current Issues*

Internationalization:

- Need to increase the science/technology component of dealings on international trade through DFAIT. Serious issue with respect to the international image of the resource sector. Government plays a role in how it is portrayed internationally.

Barriers:

- Inherent difference in culture between science and policy, including the disconnect in time lines and methodologies.
- Inter-departmental tensions; there is as yet inadequate understanding of the roles and responsibilities of other departments and their stakeholders as well as a lack of respect for the science capacity in other departments.

Cynicism:

- Scientists concern that there is not the political will to take the necessary steps to live up to international commitments such as Kyoto for fear of constitutional structure, economic disruption, belief in "let the market rule" philosophy (anti subsidy). In this case it won't be enough.

The client:

- A significant part of the NRCan activity is a sort of "science infrastructure" for the decision making of other departments and for provincial governments. Nurturing this linkage is an ongoing challenge.

## *4. Documentation*

- *Business Plan 1997-2000* From the NRCan web site http://www.nrcan.gc.ca

- *Natural Resources Canada Performance Report For the Period ending March 31, 1998.* Government of Canada

- *The Science and Technology Management Framework. May 1996.* A set of guiding principles, management tools and decision-making authorities designed to increase the effectiveness and efficiency of S&T activities in support of the sustainable development of Canada's mining, forestry and energy sectors. It focusses on return on the S&T investment and the linkage between the S&T and government priorities.

- *Compendium of S&T Management Practices. 1998 (?).* Designed by NRCan staff as a "tool box" of sound management practices relevant to the diverse components of the Department. Also designed as an assessment and evaluation tool.

- *Science and Technology in the Natural Resources Sectors: The Key to the 21st Century.* Selection of S&T Activities 1997. Published 1998. States the eight NRCan strategic goals for 1996-97 and highlights the S&T activities relating to the seven federal S&T operating principles.

- *Guide to Planning. September 1997.* Guide outlines the basic rationale and requirements of planning and reporting and covers the cross linkages among priorities, strategies, goals and implementation.

- *Framework for Revenue Generation, External Funding and Collaborative Activities.* Outlines the philosophy and principles underlying revenue generation and provides a "how to" tool kit.

- *Managers Guide to S&T Impact Assessment*. September 1997. Provides guidance on available methods for assessing the impact of S&T, and the various considerations that should be kept in mind when making choices on what process to follow. Includes some consideration of S&T for policy support and development of codes and standards.

- *Participant's Resource Materials: Policy Making - A Workshop on the Interface Between Science and Policy*. Vinzenza Galatone, Canadian Forest Service. 1999.

## Natural Resources Canada - Appendix of Reference Notes[6]

### A. S&T MANAGEMENT STRATEGY

**Objectives**

1. NRCan will incorporate a strong client focus in all S&T programs and projects to ensure that they are relevant and useful.
2. NRCan will implement rigorous accountability mechanisms for measuring and reporting progress to relevant parties, including clients and public.
3. NRCan will enhance its management practices by investing in employees.

**Guiding Principles**

1. Employees are treated fairly and they will be given the opportunities to acquire the skills and expertise they need to deliver S&T.
2. S&T involves creativity and innovation. Appropriate risk taking in the conduct and management of S&T activities is encouraged.
3. An S&T vision for NRCan and a clear definition of performance criteria are prerequisites for success.
4. Effective interaction among science, technology, policy and programs must be demonstrable.
5. A clear link to government priorities and planning is essential.
6. Accountability based on results is necessary and requires a common, yet flexible, approach among sectors.
7. Responsiveness to clients, partners and stakeholders is essential.
8. Return on public investment must be demonstrable and open to public scrutiny.
9. Effectiveness in managing S&T resources will be monitored.
10. Continuous improvement is key to good S&T management.

### B. COORDINATION OF S&T WITH POLICY ACTIVITIES

**Purposes**

1. To ensure that policy advice on government and sectoral policy priorities helps establish S&T priorities and activities.

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[6]From NRCan reference documents and web site http://www.nrcan.gc.ca

2. To ensure that sectoral policy advice is based upon sound S&T advice, knowledge and experience.
3. To ensure that S&T and sectoral policy advisors understand and support each other's initiatives in areas of shared responsibility, and give consistent advice to ministers.

**Working Assumptions**

1. Policy considerations are a crucial factor in the formulation of S&T priorities and activities.
2. Policy development and advice are based upon sound advice from S&T organizations.

**Key Elements**

1. S&T and policy advice to ministers is consistent.
2. Ensure that S&T and policy partnership are in place.
3. Establish partnerships at working, middle manager and senior manager level, as appropriate, allowing for information to be passed from S&T to policy and vice versa.
4. Record decisions related to advice.
5. Report back jointly on resulting actions to parties involved.
6. Review regularly the partnership process.

## C. CONSULTATION WITH CLIENTS AND STAKEHOLDERS ON S&T PROGRAMS

**Purposes**

1. To ensure that the views of clients and stakeholders are known and considered.
2. To obtain buy-in and support from clients and stakeholders.
3. To open and maintain an effective dialogue.
4. To initiate contact for future business opportunities and partnerships.

**Working Assumptions**

1. Consultation is the most efficient way to obtain the necessary information.
2. Consultation with clients and stakeholders can be either formal or informal, periodic or ongoing.
3. Consultation is carried out at all stages of management (planning, organization, implementation, monitoring and evaluation).

**Key Elements**

1. Develop a consultation strategy and mechanisms for each consultation:
   - Define needs and objectives;
   - Identify and select clients and stakeholders (should cover client base - current and potential); and

- Establish mechanisms and schedules for consultation.

2. Contact clients and stakeholders (e.g., through phone interview, Internet survey, meeting).
3. Compile, analyze, evaluate the information and validate the information gathered with clients and stakeholders.
4. Integrate consultation outputs into the decision-making process.
5. Communicate results of decision making to clients and stakeholders.
6. Maintain an ongoing dialogue.
7. Synchronize the various consultative processes for programs and projects with the same clients and stakeholders.

## D. HUMAN RESOURCES MANAGEMENT FOR S&T ORGANIZATIONS

**Purposes**

1. To provide S&T managers with the means to manage effectively human resources.
2. To optimize the effectiveness of staff by ensuring a healthy and favourable work environment, by continuing to attract the right people, and by developing and motivating them.

**Working Assumptions**

1. Effective S&T requires skilled, highly trained and highly motivated scientists, technicians and managers. In meeting current and future recruitment needs, federal organizations will have to compete with the private sector and other levels of government.
2. S&T organizations have clear and commonly understood mission and goals around which staff can be mobilized within evolving mandates, roles and responsibilities.
3. Management of human resources is achieved within a culture and under a leadership that emphasize excellence. That culture reflects program values (service quality, economy, efficiency, effectiveness and the value of diversity), and promotes ethical values (fairness, prudence, probity, equity and non-partisanship).
4. Leadership involves integrity and credibility on the part of senior and middle management, team leaders and team members. Shared leadership, innovation and risk-taking, empowerment, upward feedback, teamwork, collaboration and client service have become increasingly important.
5. The planning and management of human resources involve addressing through a common framework organization-wide concerns such as future labour needs and availability, promotion, training and retraining, mobility, performance, morale issues, etc. Needs analysis and succession planning are especially important in the highly specialized S&T environment.
6. A healthy and favourable work environment is especially important in fostering creativity, teamwork, change and productivity in S&T organizations. People are valued as key assets to be

managed wisely. Staff are encouraged to achieve their full potential and share responsibility for continuous learning and growth.

7. Management communicates to employees its commitment to adhere to all federal human resource directives, policies, regulations and procedures that impact on human resources (e.g., Official Languages, Employment Equity, Harassment, Workforce Adjustment policies, etc.).
8. Increased management flexibility is required for hiring, demoting, letting go and reassigning staff to respond quickly to S&T opportunities and to changing priorities when the required skill mix changes.
9. Given the fast pace of S&T changes, managers and employees work jointly to seize opportunities for training and development in new skills to meet performance expectations; managers have increased flexibilities on conference participation and work travel.
10. Promotion criteria and rewards are based on contribution to the objectives of the S&T organizations, including client satisfaction. Performance standards are clearly defined and understandable.
11. A close working relationship exists between senior managers and employee bargaining agents.

**Key Elements**

1. Analyze future labour requirements (e.g., forecast departures, confirm requirements of positions to be filled). Forecast future supply; plan and implement initiatives to avoid labour shortages and to rejuvenate the workforce (e.g., explore alternatives to recruitment such as secondments from outside the department, contractors, etc.).
2. Managers and employees work jointly to develop and implement a plan for career management. This is achieved by identifying gaps between employees profile and career aspirations and organizational needs, evaluating employees' potential and discussing possible measures to achieve career expectations and enrichment.
3. Managers and employees work jointly to develop learning initiatives to ensure continuous improvement and innovation. This is accomplished by identifying and prioritizing learning needs, determining ways for acquiring competencies (e.g., management training for senior scientific staff), and evaluating the impact of training programs on organization's effectiveness.
4. In consultation with employees, manage performance by setting explicit roles and work objectives, coaching, counselling, monitoring, providing ongoing feedback, evaluating performance, dealing with ineffective performance and linking these activities with organizational objectives, incentive and performance pay, training, promotion, and career and succession planning.
5. Address further the question of promotion by establishing clearly defined promotion criteria aligned to business objectives, elaborating promotion plans (e.g., training, rotational assignments, tutoring), and determining methods for assessment and evaluation.
6. Establish a system of incentives, clearly defining what is to be recognized, how, and why.

## E. SCIENTIFIC ASSESSMENT

**Purpose**

1. To provide S&T organizations with scientific assessments of their S&T programs or projects.

**Working Assumptions**

1. S&T organizations periodically assess their S&T programs or projects.
2. All S&T activities conducted or delivered by the S&T organizations are assessed.

**Key Elements**

1. Put in place an objective peer review process to assess the overall direction and level of effort, adequacy of coordination and collaboration, and scientific quality, and to provide up-to-date and forward-looking assessments of the S&T programs or projects.
2. Link scientific assessment with project management, including the development or updating of S&T strategic and business plans; as appropriate, incorporate the results of the assessments into such plans, and into the resource allocation and the external evaluation processes.
3. Establish assessment panels that reflect internal and external scientific expertise and the breadth of partners' and stakeholders' interest and involvement in the research.
4. Foster direct participation by research managers and scientific staff in the assessment.
5. Assign responsibility for follow-up actions to appropriate program managers and project leaders.
6. Communicate follow-up actions to scientific staff and the review panel.

## F. EXTERNAL S&T COMMUNICATIONS

**Purposes**

1. To inform clients, partners, stakeholders, employees of the S&T organization and the general public about its activities, services, products and policies, and impacts of its activities.
2. To provide them with a means to have their concerns and interests taken into account in the formulation and implementation of policies, programs and projects.

**Working Assumptions**

1. Communication is an essential management tool for:
   - increasing the science awareness of the Canadian public;
   - generating business opportunities, increasing sales and encouraging partnerships;
   - creating awareness, by demonstrating the value and benefits of S&T to Canada;

- enhancing employees' awareness of external communications requirements, with the view of providing a more sensitive, responsive service to the public, clients and stakeholders; and
- providing clients, partners, stakeholders and employees opportunities to influence the development and implementation of policies, programs and projects.

2. Scientific and communication staff are aware of their respective roles and responsibilities and the need to maintain effective internal working relations.
3. S&T organizations have a coherent corporate approach to S&T communications.

**Key Elements**

1. Ensure the existence of an S&T communications infrastructure which provides a proactive S&T communications strategy that incorporates an international perspective.
2. Provide accurate, clear and consistent information and messages to targeted publics.
3. Provide the means for dialogue between S&T staff and external audiences.
4. Integrate communications plan and activities in project management.
5. Explore and use all appropriate forms of communications vehicle.

## G. EXTERNAL REVIEWS OF PROGRAMS IN THE EARTH SCIENCES SECTOR

The terms of reference for this review follow the general prescription adopted by NRCan for reviews of programs in the Earth Science Sector. These are as follows:

**General**

1. Determine and document the current level and types of science activities within the program under review;

2. Assess the relevance and adequacy of these activities to users in industry, university and government sectors, and for the sectoral and departmental national responsibilities and mandates;

3. Assess the timeliness, relevance, quality and quantity of publications reporting on the results of science activities within the program under review;

4. Assess the range, adequacy and quality of research infrastructure available to support the science activities within the program under review;

5. Examine the methods and procedures used in originating, implementing, assigning priorities and managing research projects within the program;

6. Identify new potential initiatives and opportunities for the program;

The Review Agency(ies) will report their findings and appropriate recommendations in writing to the Assistant Deputy Minister, Earth Sciences Sector. The report of the Agency will be made public, but the mechanism and format of publication will be determined by mutual agreement of the Assistant Deputy Minister, Earth Sciences Sector and the Review Agency(ies);

The Minister's National Advisory Board for Earth Sciences (MNABES) will assess the reviews with respect to the methodologies, standards, conclusions, and recommendations, therein, and report their assessments to the Assistant Deputy Minister.

**Accountability**

The Review Agency(ies) is accountable to the Assistant Deputy Minister, Earth Sciences Sector.

**Duration**

The Review Agency(ies) will issue an interim report within three months from the date of the commencement of the review. The final report will be issues not more than three months later.

**Composition of Science Review Panels**

Nominees to the Review panels will be selected jointly by the ESS science program managers and the Review Agency(ies) with each having a veto over the other's nominations if the qualifications or specialization of nominees are considered inappropriate. The Chief Geoscientist would ensure that the review process is rigorous and conforms with best practices in this field; that there are no conflicts of interest among the peer reviewers; and that review panels contain a good representation of peers from the diverse client base.

Each Review Panel will:

- be composed of top-quality scientists and R&D managers from universities, industry and government, and be specialists in the fields under review. Each panel can include members of the international scientific community. No panel member will participate in a review of his/her own research establishment.
- have full access to previous peer quality review processes.

**Advice/Consultation**

The Review Agency(ies) can seek advice and counsel from any source (national or international) it deems appropriate.